August 2000

FISH PASSAGE CENTER

Annual Report 1999

DOE/BP-15377-2

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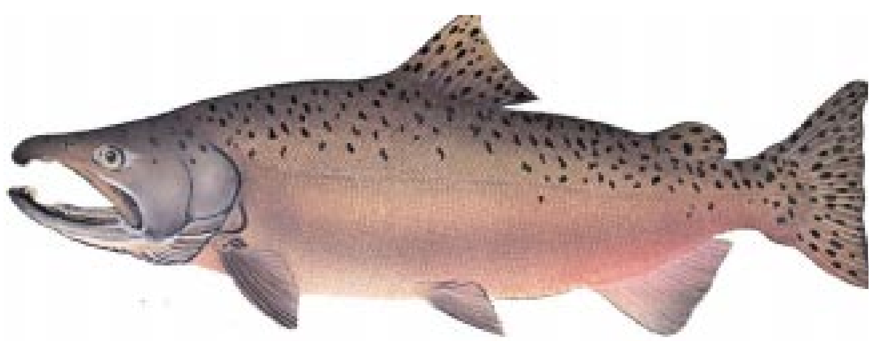
FISH PASSAGE CENTER

1999 ANNUAL REPORT

Fish Passage Center
of the
Columbia Basin Fish & Wildlife Authority



August, 2000

FISH PASSAGE CENTER

ANNUAL REPORT

1999

This report responds to the Fish Passage Center annual reporting requirements to the Northwest Power Planning Council under its Columbia River Basin Fish and Wildlife Program, and the annual reporting requirements to the Bonneville Power Administration under its funding contracts which supported this work.

BPA CONTRACT #94-033

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Acknowledgments

We thank all the individuals, agencies, and organizations who contributed to the successful completion of the 1999 program.

We extend thanks to the hatchery release coordinators, managers, and staffs of all basin facilities for providing timely information on hatchery releases. We are indebted to the managers and staffs of Wells, Winthrop, Leavenworth, Priest Rapids, Rapid River, McCall, Dworshak, and Lookinglass hatcheries, all of whom supplied fish and logistical assistance for the marking program. We extend a special thanks to those who PIT tagged fish for the Smolt Monitoring Program (SMP). Fish marking was carried out by U.S. Fish and Wildlife Service (USFWS), Idaho Department of Fish and Game (IDFG), Oregon Department of Fish and Wildlife (ODFW), Nez Perce Tribe (NPT), and Washington Department of Fish and Wildlife (WDFW).

We appreciate the efforts of the field crews at each of the monitoring sites. Sampling and reporting were carried out by WDFW at Rock Island, Ice Harbor, McNary, Lower Monumental, and Lower Granite dams; by ODFW at Little Goose Dam and Grande Ronde River trap; by Pacific States Marine Fisheries Commission (PSMFC) at John Day and Bonneville dams; by Chelan County PUD at Rock Island Dam; by NPT at Imnaha River trap; and by IDFG at the traps on the Salmon and Snake rivers.

In addition to the aforementioned monitoring supported under the SMP, related activities by others, such as the fish transportation program supported by the U.S. Army Corps of Engineers (COE), provided valuable information at various monitoring sites. The COE also provided facilities and accommodations for smolt monitoring activities at their projects. This report was prepared by the Fish Passage Center staff: Michele DeHart, Tom Berggren, Margaret Filardo, Larry Basham, Dusica Jevremovic, Henry Franzoni, Sergei Rasskazov, Jerry McCann, Deidre Wood, and Dona Watson.

The project was funded by Bonneville Power Administration (BPA), under the northwest Power Planning Council Fish and Wildlife Program, Section 303 (d) (1), BPA Project #94-033.

Executive Summary

Although 1999 had the third highest runoff volume since 1992, there were several periods in which the NMFS Biological Opinion target was not met on a weekly basis. This was primarily due to overly conservative flood control operation and stream flow forecasting, which did not consider the occurrence of less than average precipitation in planning short and long-term future operations.

Migration flows for the spring and summer migration period met the seasonal biological opinion targets due to the high run off volume. The system was primarily operated for flood control and power production purposes. The Biological Opinion measures were not a primary factor in the operation. The high run-off volume incidentally resulted in higher migration flows and spills for fish passage than would have occurred from implementation of the Biological Opinion measures alone.

Although dissolved gas waivers were obtained to facilitate fish passage at the Columbia and Snake River mainstem projects, the failure to obtain a similar dissolved gas waiver relative to the operation of Dworshak reservoir limited the ability to meet the summer migration flow target at Lower Granite Dam. This resulted in reduced flow levels at Lower Granite for summer migrants. The dissolved gas waiver determined the flows at Lower Granite. The delayed snowmelt resulted in shaping flow such that dissolved gas levels rarely exceeded the waiver standards.

As in past years, the operation of Canadian projects was not prioritized to meet biological opinion measures. Modifications in Canadian reservoirs operation could improve the implementation of biological opinion measures. The operation of Canadian reservoirs would be even more significant in average and below average run off volume years.

As in past years it was apparent that the operation of the USBR reservoirs in the Upper Snake River above the Hells Canyon complex did not reflect the best possible operation for fish passage. The USBR reservoirs have potential to improve fish passage conditions in early April by modifying their flood control and refill operation to complete refill in March and avoid refill in April. Snake River summer operations were for fish migration was limited, as in past years by: 1) the failure of the State of Idaho to issue a dissolved gas waiver 2) the limit of flow at the Milner plant to hydraulic capacity during the salmon migration period, 3) the recreational reservoir elevation limit at Brownlee and 4) the scheduled maintenance of the Hells Canyon project during the migration period which limited hydraulic capacity.

Fish passage timing and travel time showed the affect of higher flows and spill. Travel time in the lower Columbia River was reduced to four days at peak flows. A higher percentage of spring migrants passed in spill at mainstem projects this year.

Hatchery production in the Columbia River Basin above Bonneville Dam was 79.4 million salmonids.

The adult count data for 1999 was in general near or above the 1998 count and above the ten-year average for most species with the exception of Mid-Columbia sockeye which had the fourth lowest return on record and was well below the 10-year average.

I. 1999 WATER SUPPLY

A. Precipitation-Water Supply Forecasts

- **Monthly precipitation varied widely from the thirty year average (1961-1990) normal during the year. This combined with brief periodic warming resulted in significant changes in runoff volume forecasts. This in turn affected reservoir flood control operations.**
- **Runoff Volume forecasts increased through March, resulting in reservoir flood control overdrafts relative to the final April and May runoff volume forecasts. This negatively impacted spring migration conditions.**

Cumulative precipitation records for the October-April period were at average and above average for the whole basin: 108% at Columbia above Grand Coulee, 107% at Snake River above Ice Harbor and 110% at The Dalles.

A summary of the monthly cumulative precipitation for the Columbia above Grand Coulee, Snake River above Ice Harbor and Columbia above The Dalles is given in the Table 1.

TABLE 1. Monthly cumulative precipitation presented as percent of normal at: The Dalles, Ice Harbor at Snake River and Columbia above Grand Coulee.

Month	Columbia above The Dalles	Snake River above Ice Harbor	Columbia above Grand Coulee
	% of average 1961-1990	% of average 1961-1990	% of average 1961-1990
October	68	66	76
November	142	133	139
December	120	88	128
January	105	109	101
February	156	185	137
March	76	61	80
April	63	83	62
May	79	95	70
June	95	99	107
July	74	32	88
August	122	101	131
September	34	23	47

The precipitation for the month of October was below 70% for most of the basin resulting in below average inflows in the system. The basin experienced average and above average precipitation during the November through December period. The lowest monthly cumulative precipitation was 88% of average at the Snake River above Ice Harbor in December and the highest was 142% of average for the Columbia River above The Dalles.

In the winter period, January through March, the highest precipitation was 185% of average occurring in February and the lowest was 61% of average occurring in March for the Snake River above Ice Harbor. March precipitation was well below average for the entire basin, resulting in decrease in the April Final Runoff Volume Forecasts.

In the April through June period, monthly precipitation was below average in most of the basin, contributing to lower flows than BiOp targets in April and May in the system and a subsequent decrease in May Final Runoff Volume Forecast. The exception was for the Columbia River above Grand Coulee with precipitation of 107% of normal in June.

Precipitation in July and September was well below normal for all three sites, in the range of 23%-88%. August precipitation was average for the Snake River above Ice Harbor and above average (131% and 122% of normal) for Columbia above Grand Coulee and The Dalles, resulting in above average flows in system for that period of the year. Figure 1 shows the wide variation from average in monthly precipitation for the period of January-August, compared with the monthly volume runoff forecasts for the January through July period at The Dalles. Failure of assumption that precipitation is average during the January through July period to materialize in the process of forecasting volumes resulted in overestimation of the runoff volumes for the spring period.

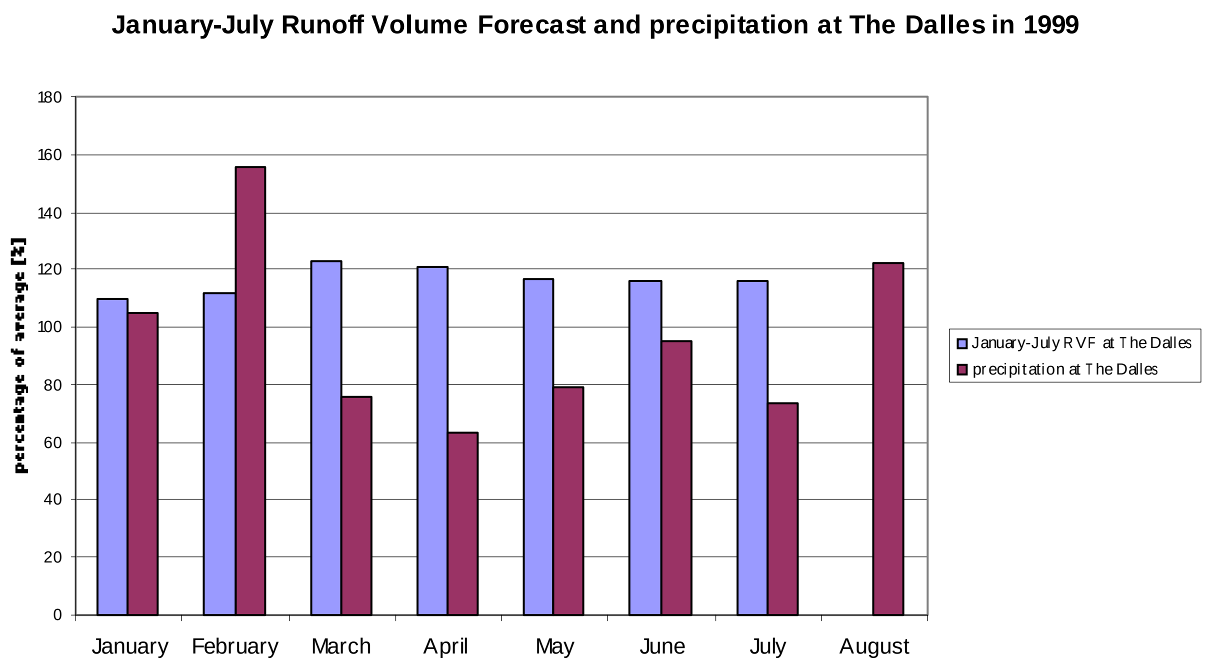


FIGURE 1. Monthly precipitation for January-August period and January-July runoff volume forecasts at The Dalles.

The year started with snow water equivalents ranging from 80% in southeastern Idaho to 180% in parts of the Washington Cascades, and northern areas of the Columbia. Snowpack continued building during February, but a 5 to 7 day warm spell during March caused snowmelt, resulting in decreasing the snowpack 3% to 20% and a decrease in the April Runoff Volume Forecasts. Mid-late April warming and snowmelt occasionally reached northward beyond the Middle-Upper Snake into the Upper Columbia and caused an increase in river flow. April snow water equivalents generally decreased for most of the basin. Cool temperatures in May slowed the snowmelt contributing to low flows in the basin after the May Final Runoff volume forecast decreased and reservoirs had been previously drafted for flood control in January through April period. Short period of higher temperatures at the beginning of May resulted in a brief initiation of the snow- melt. Finally major snowmelt occurred during June, although the temperatures were lower than average for that period of the year.

The runoff volume forecasts for 1999 are displayed in Table 2. Spring migration flows for fish were affected by drafting reservoirs to lower elevations based upon the higher forecasted levels for the January-March period. Decline in the subsequent April forecast resulted in the major storage reservoirs starting at a lower than necessary elevation.

By the end of the period runoff volume forecasts in the Upper Columbia decreased from 2% at Libby to 15% at Hungry Horse for March through July, resulting in delayed refills. The Runoff Volume Forecast for Grand Coulee varied from 109% in January to 117% of average in March and April, with observed value of 115% of normal for the January to July period. The failure of March and April predictions to materialize was due to overestimated snowpack and precipitation, which was well below normal during March through May period, resulting in lower flows than projected in the system during spring.

The largest decrease in runoff volume forecast for Snake Basin occurred for the Clearwater River drainage, declining from 126% to 114% of normal from April to July. This resulted in lower spring flows and delayed refill of the Dworshak reservoir. At the same time the runoff volume forecast for the Mid Snake drainage for Brownlee reservoir declined 18% from March to April and then increased 7% from April to July, resulting in a March to July decline of 11%. Runoff volume forecast for January through July period increased to 127% in March from 110% in February due to above average precipitation in February of 185% and snowpack accumulation at Lower Granite (Table 2). March Final and April Final Runoff Volume Forecasts for the January to July period were overestimated due to assumptions of average precipitation, which failed to materialize. May and June precipitation in the basin were close to normal and building of snowpack was finished, so May and June Runoff Volume Forecasts were the same as observed runoff volume for the January-July period. Overestimation of runoff volumes in March and April period resulted in overdrafting of reservoirs for flood control and lesser volume of water for spring flows in the Lower Snake. A summary of the forecasted volumes is given in Table 2.

TABLE 2. Forecasted Volumes for 1999.

Forecast Month	Libby (Apr-Sep)		Hungry Horse (Apr-Sep)		Grand Coulee (Apr-Sep)		Brownlee (Apr-Jul)		Dworshak (Apr-Jul)	
	MAF	% avg	MAF	% avg	MAF	% avg	MAF	% avg	MAF	% avg
January	6.91	102	2.33	107	70.4	109	5.73	99	3.3	115
February	7.33	108	2.4	110	73.1	113	5.93	102	3.1	115
March	7.53	111	2.48	114	76.4	118	8.38	145	3.6	133
April	7.39	109	2.38	109	73.8	117	7.36	127	3.4	126
May	7.16	106	2.31	106	72.4	114	7.32	126	3.2	119
June	7.17	106	2.24	103	72.2	114	7.51	130	3.13	116
July	7.37	109	2.16	99	73.5	113	7.75	134	3.09	114

Forecast Month	Columbia above The Dalles (Jan-Jul)		Snake River above Lower Granite (Jan-Jul)	
	MAF	% of avg	MAF	% of avg
January	116.0	110	32.7	110
February	119.0	112	32.8	110
March	130.0	123	37.9	127
April	128.0	121	36.5	123
May	124.0	117	35.8	120
June	123.0	116	35.7	120
July	123.0	116	35.7	120

Comparison of the historic run-off volume data for two reference sites in the Columbia Basin is given in Table 3. This shows that 1999 was one of the highest water years of the 1992-1999 period. Observed runoff for January through July period was well above average, and lower than 1996 and 1997. In spite of this, the May flows were lower than BiOp required minimum target due to delayed snowmelt and conservatively drafted reservoirs for flood control during winter.

TABLE 3. January-July Actual Volumes for 1992-1999.

Year	Columbia above Grand Coulee		Columbia above The Dalles		Snake River above Lower Granite	
	Runoff Volume [MAF]	% of avg	Runoff Volume [MAF]	% of avg	Runoff Volume [MAF]	% of avg
1992	46.5	74	70.4	66	14.1	47
1993	49.1	78	88.0	83	26.7	90
1994	50.9	80	75.0	71	15.9	53
1995	59.0	93	104.0	98	29.4	99
1996	78.9	135	139.3	132	42.4	143
1997	88.2	137	159.0	150	49.5	166
1998	59.0	93	104.5	98	31.3	105
1999	71.3	115	124.1	117	36.1	121

B. Operational Guidelines 1999

- **The implementation of fish protection measures occurred under the auspices of the federal agencies records of decision and the NMFS Biological Opinions for 1995 and 1998.**
- **The hydrosystem operational management in 1998/1999 for fish passage was conducted through the Technical Management Team, TMT, an inter-agency team comprised of representatives of Federal Operating Agencies (COE, BOR, BPA) and State and Federal Fish and Wildlife Agencies (NMFS, USFWS, ODFW, WDFW, IDFG).**

Guidance for implementation of fish protection requirements for fish passage were based on the National Marine Fisheries Service (NMFS) 1995 Federal Columbia River Power System (FCRPS) Biological Opinion and NMFS 1998 Supplemental Steelhead Biological Opinion. NMFS concluded in the supplemental opinions that existing measures were providing adequate protection to ensure survival for the interim period. Implementation of Biological Opinion measures for fish passage conditions was in some circumstances precluded with flood control, power and maintenance operations.

NMFS agreed that protection was needed for the sixth listed species, Columbia River chum salmon, pending a listing as endangered. The NMFS 1995 Opinion and 1998 Supplemental Opinion, including the 1995 RPA and the 1995 and 1998 incidental take statements, continued in full effect. Previously ESA listed Snake River spring/summer/fall chinook and sockeye and mid-Columbia steelhead resulted in required protection flows for Lower Snake and mid/lower Columbia Rivers during the spring and summer period.

1. Fall/Winter Operation

- **During the fall and winter period reservoirs were operated for flood control and power production.**
- **Fish protection requirements were in place for Vernita Bar fall chinook spawning. Fish spawning protection for chum and fall chinook below Bonneville Dam were discussed.**

(Detailed reservoirs operation data is included in Appendix A).

The flow requirement for Vernita Bar, below Priest Rapids Dam was established during October at a minimum daily average of 65 kcfs, according to the terms of the Vernita Bar settlement agreement. The Salmon Managers requested flows below Bonneville on the basis of ongoing research to protect fall chinook and chum spawning. The Salmon Managers requested instantaneous flow of 130 kcfs from October 15 through November 15, and a flow of 150 kcfs from November 16 through December 31 for utilization and access to spawning habitat. The Salmon Managers request for flows below Bonneville was not met for October, at issue was the risk of impacting the spring reservoir elevation targets by deeper drafts of storage reservoirs in the fall. The hydro-system was operated primarily to meet power generation demands during the October-December period. Deeper drafts of the Upper Columbia reservoirs would have met the Salmon Managers request. Instead, reservoirs were proportionally drafted according to the second year critical curve, as the inflows were in the range of 70% to 118% of average during the October-November period. This was not adequate to meet the Salmon managers flow request during the October-November period. An additional draft of 526.6 ksfd would have met flow requirement during the first part of the spawning period from October 15 through November 15. The system was returned to the first year critical curve draft in December. The average flow was 155.2 kcfs during the second part of the spawning period from November 16 through December 31. The flow was shaped according to power generation demands, and not to fishery needs. The summary of October 1 and the end of December elevations for the major system reservoirs is presented in Table 4.

TABLE 4. End of December 1998 Reservoir Elevations

PROJECTS	Actual elevation on October 1 [ft]	Actual Elevation on December 31 [ft]
Libby	2437.72	2405.56
Hungry Horse	3535.77	3522.26
Grand Coulee	1281.75	1278.42
Brownlee	2019.72	2072.0
Dworshak	1519.12	1533.43

Grand Coulee was refilled from 1281.75 ft to 1283.25 ft in October, and drafted to 1278.1 ft by the end of December. Brownlee refilled from October 17 through December 17, releasing minimum flows of 9.5 kcfs as a part of their fall chinook spawning operation below Hells Canyon Dam. Dworshak maintained minimum outflow of 1.4 kcfs during the entire fall period.

Winter hydro-system operations were characterized with reservoir drafting for power generation, flood control requirements and maintenance. Actual and flood control required elevations for the January-April period are shown in Figure 2 (pages 8,9 & 10).

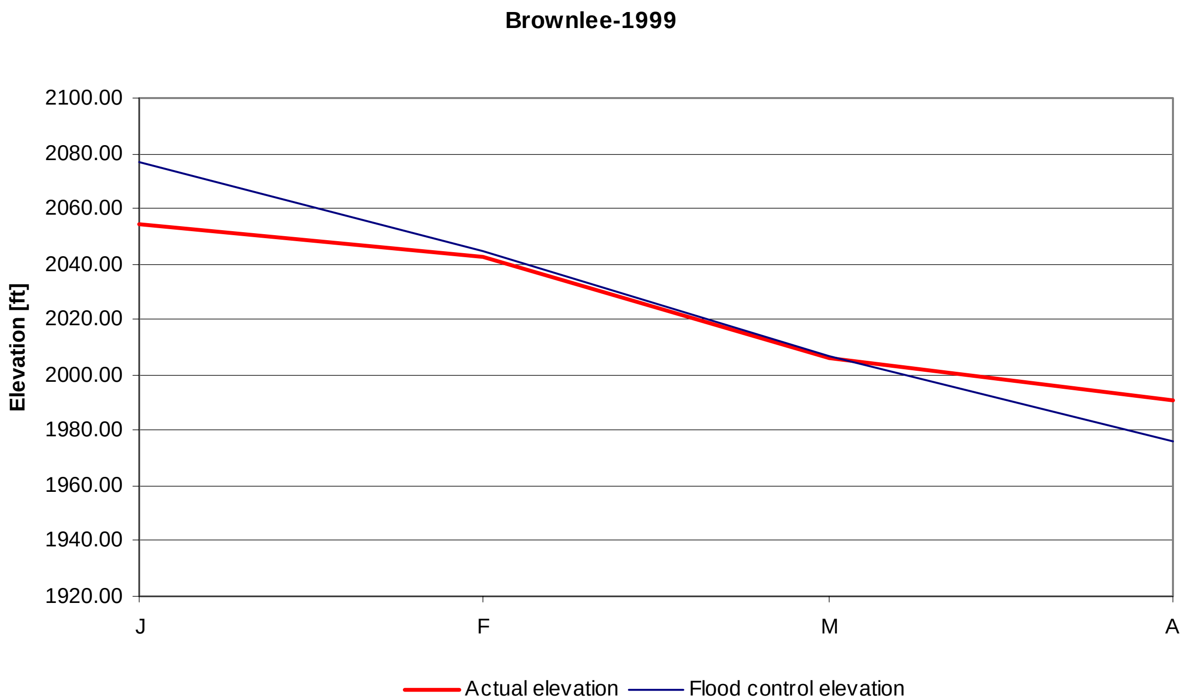
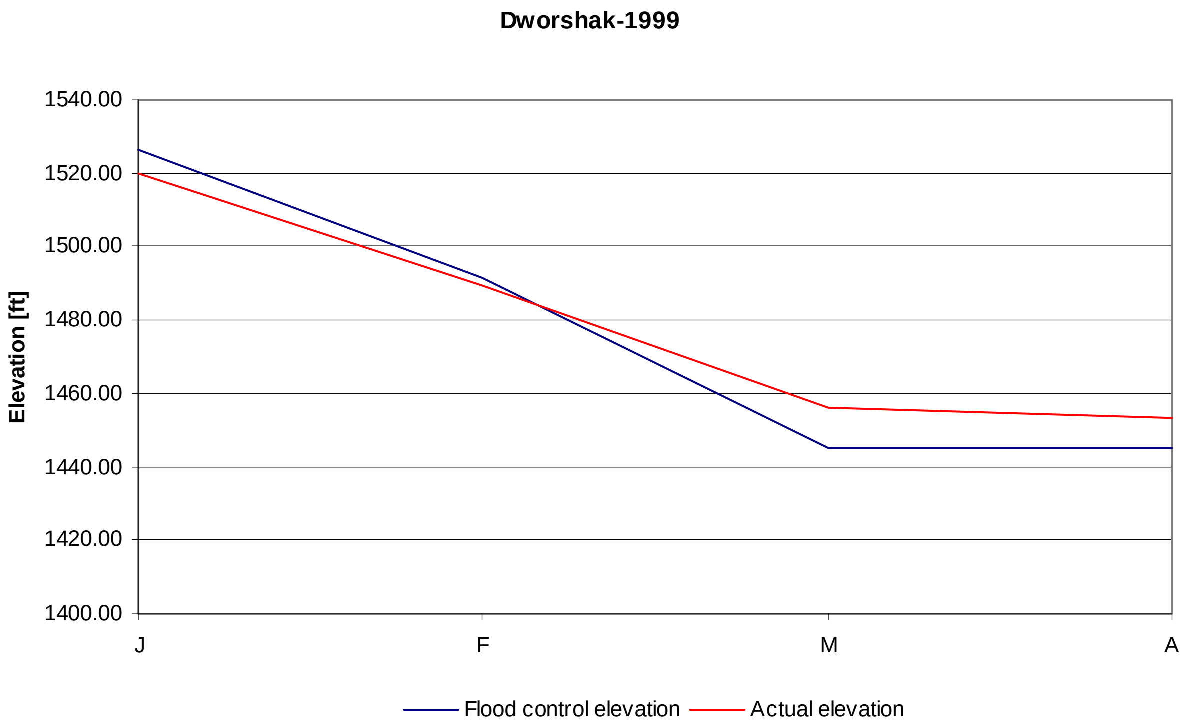


Figure 2: Required flood control elevations and observed elevations at major reservoirs in the basin.



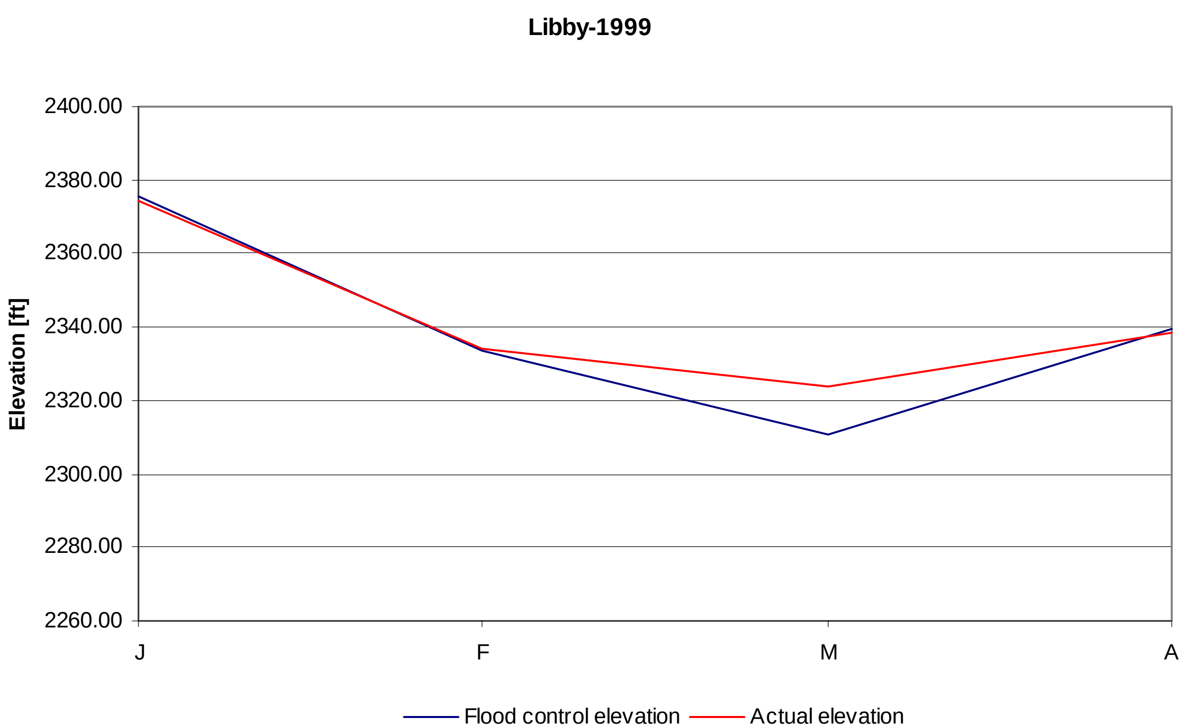
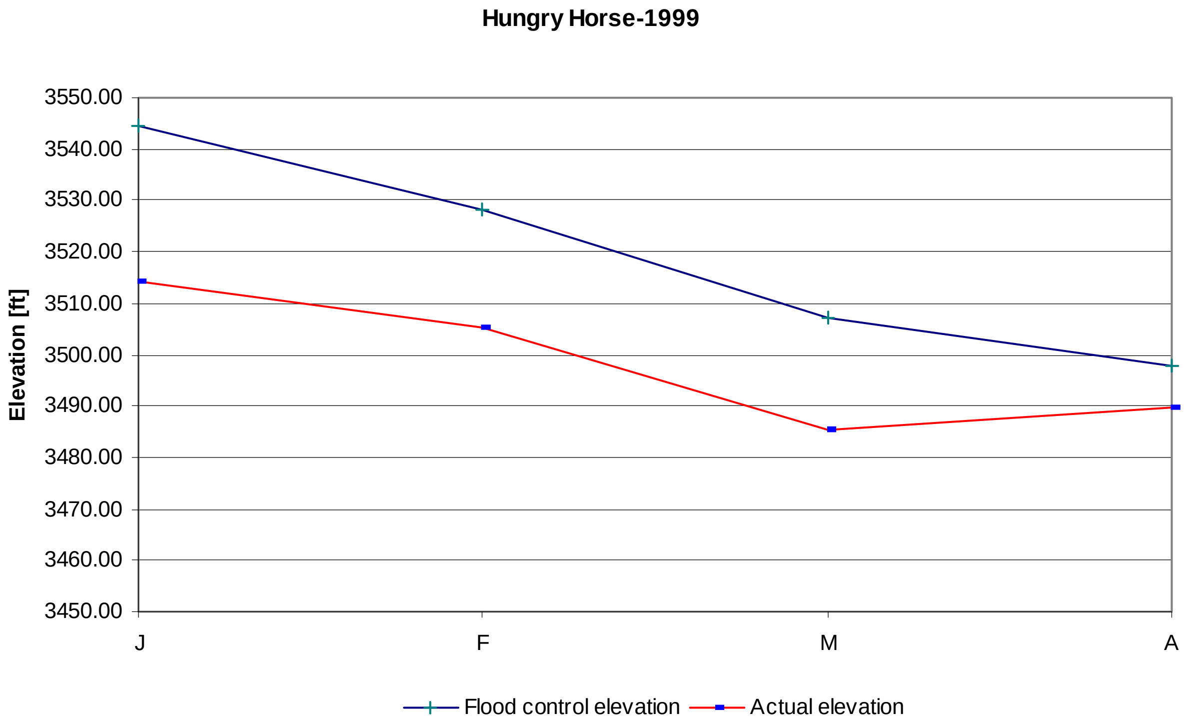


FIGURE 2. Required flood control elevations and observed elevations at major reservoirs in the basin.



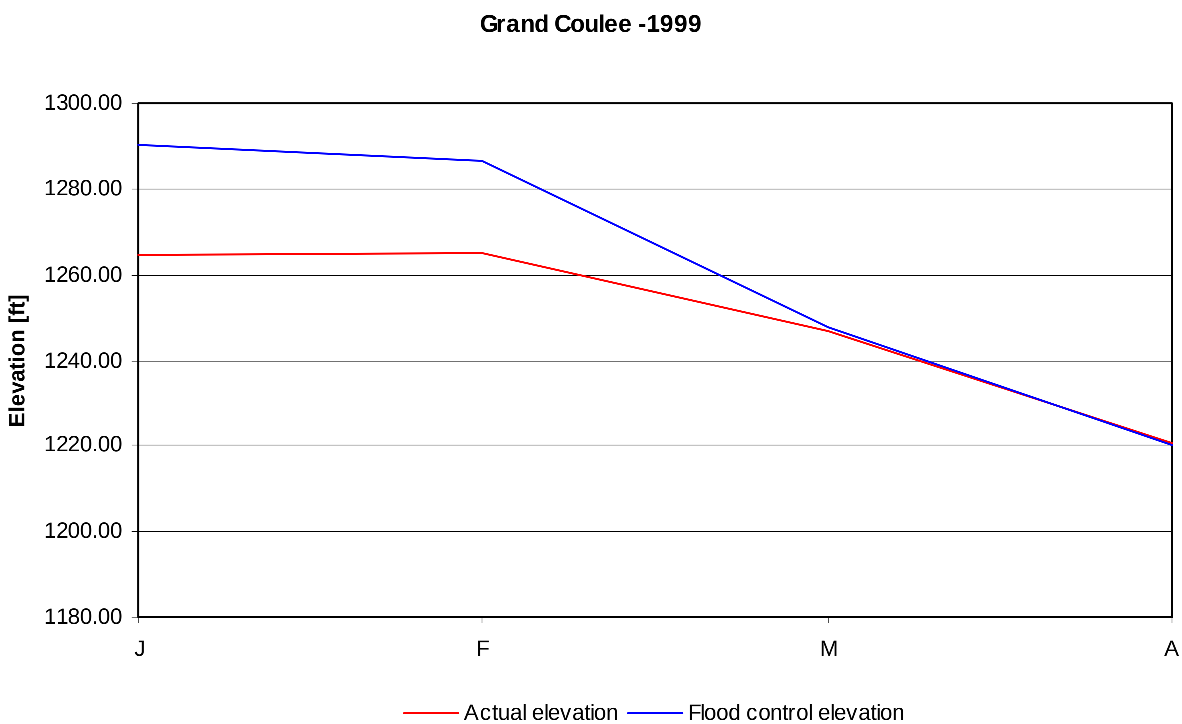


FIGURE 2. Required flood control elevations and observed elevations at major reservoirs in the basin.

High precipitation during January through February period and resultant above average runoff volume forecasts resulted in deep flood control drafts from reservoirs and subsequent high flows. However, the major reservoirs, with the exception of Libby, were drafted below flood control required elevations during the January-February period for power generation. This resulted in higher flows than the minimum requested by Salmon Managers below Bonneville Dam. Most of the reservoirs were drafted at slower rate, than their allowed maximum. Resulting March flows at Bonneville were higher than minimum requested by Salmon Managers. At the end of March, Hungry Horse was overdrafted below required flood control elevation (FCE) 21.5 ft for maintenance purposes, while Libby's elevation was held 12.6 ft above flood control curves as COE decided at the beginning of March to operate Libby at minimum outflow. The goal of this operation was to refill the reservoir to an April 30 elevation, increasing chances for refill to the full pool by June 30, while meeting multispecies requirements in spring. Grand Coulee was slightly overdrafted 0.9 ft below the flood control elevation. Dworshak elevation was held 11.2 ft above flood control elevation because the outflow was limited to 14 kcfs to avoid Exceedences of the 110% dissolved gas saturation standards at the tailrace of the dam. During this period, inflows were 139% of average in March. Dworshak reached the 1445 foot elevation by April 8. The summary of flood control requirements on March 31 and actual elevations, minimum winter elevations/ dates are presented in Table 5.

TABLE 5. End of March Required Flood Control Elevations at Reservoirs.

PROJECTS	Required Flood Control Elevation on March 31[ft]	Actual Elevation [ft] on March 31	Min/Max Pool Elevation [ft]	Max. 1999 Winter Draft and Date
Libby	2310.9	2323.5	2287.0/2459.0	2321.29 ft as of March 20
Hungry Horse	3507.1	3485.59	3336.0/3560.0	3485.59 ft as of March 31
Grand Coulee	1247.7	1246.8	1208.0/1290.0	1246.75 ft as of March 31
Brownlee	2006.8	2006.3	1976.0/2077.0	2006.34 ft as of March 31
Dworshak	1445.0	1456.2	1445.0/1600.0	1456.21 ft as of March 31

2. Spring/Summer Operations

- **During the spring and summer period, the reservoir system was operated for flood control, power production and implementation of Biological Opinion measures.**
- **Late winter and early spring reservoir drafts for flood control resulted in lower early spring migration flows for salmon.**

The Supplemental Steelhead 1998 Biological Opinion superseded 1995 Biological Opinion requirements in timing of the flood control operations. The Steelhead 1998 Opinion specified that Libby, Hungry Horse and Grand Coulee should be on their flood control elevations on April 10, when the migration season begins in the mid-Columbia reach. Reservoirs were required to be at their flood control elevations on April 10, to increase the likelihood of meeting spring flow targets at Priest Rapids and McNary and to meet the probability of refill to full pool by June 30, as summarized in Table 6. The Snake River reservoirs are required by the 1995 Biological Opinion to be at their flood control elevations by April 20 to meet the probability of refill by June 30 and to meet spring BiOp flow targets at Lower Granite and McNary dams, as summarized in Table 6.

TABLE 6. Spring Flood Control Elevations at Reservoirs.

Project	COE Required Flood Control Elevation on April 30 [ft]	Actual Elevation on April 30 [ft]	Opinion Required Elevation on April 10*/20** [ft]	Actual Elevation on April 10/20 [ft]	Maximum Draft Achieved During Spring Season [ft]
Libby	2339.8	2338.6	2319.9***	2324.09 as of April 10	2321.29 as of March 20
Hungry Horse	3491.0	3489.48	3499.9*	3483.20 as of April 10	3482.87 as of April 16
Grand Coulee	1220.2	1220.35	1238.5*	1236.70 as of April 10	1220.35 as of April 30
Brownlee	1976.0	1990.54	1986.3**	1991.0 as of April 20	1989.74 as of April 27
Dworshak	1445.0	1453.37	1447.1**	1448.9 as of April 20	1445.32 as of April 15

* The April 10 elevation determined by linear interpolation between end of March and April flood control elevations based on March Final Runoff Volume forecast

** The April 20 elevation determined by linear interpolation between end of March and April flood control elevations based on March Final Runoff Volume forecast

***The April 10 approximately calculated BiOp required elevation based on March Final end of March FCE and April Final end of April FCE

The 1998-1999 experience showed that the Federal Agencies practice of planning maintenance operations during winter months, in addition to maximizing draft for power generation and conservative flood control strategies resulted in not meeting the BiOp required flows at Priest Rapids, Lower Granite and McNary at the beginning of the salmon migration season.

The COE operated the system based on forecasting models that didn't include any consideration of lower than average precipitation occurrences in flood control operations (all Streamflow Synthesis and Reservoir Regulation Model (SSARR) runs were based on average precipitation for the period October-March. SSARR runs showed that spring flow targets would be met during the whole spring season. There was no consideration at the very beginning of the migration season, of the impact of different hypothetical weather patterns which could develop and which could impact migration flows. The April Final Runoff Volume Forecast decreased, resulting in required higher flood control elevations of the reservoirs for the end of April than previously anticipated. Failure to refill major augmentation reservoirs in the Upper Columbia by April 10 to BiOp required elevations resulted in 397.9 KAF less in the reservoirs at the beginning of the spring migration season. The problem of inaccurate SSARR projections continued throughout the spring period. Although a colder than normal weather pattern was predicted, the COE continued to include normal weather assumptions in their SSARR projections.

A brief synopsis of spring and summer reservoir operations follow:

Hungry Horse was overdrafted during winter for maintenance work, and remained 16.7 ft below required April 10 BiOp elevation, resulting in 292.3 KAF less water in the reservoir at the beginning of the fish migration season. April Final Runoff Volume forecast decreased, resulting in higher required refill than previously anticipated. Hungry Horse remained 1.5 ft below required flood control elevation through the end of April, resulting in 26 KAF of water less in the reservoir at the end of April than required by flood control operations and available for flow augmentation. Hungry Horse was operated according to Integrated Rule Curves defined by State of Montana resulting in delayed refill of the reservoir to July 25, rather than June 30 target. This operation shifted 222 KAF from summer into spring.

Grand Coulee was overdrafted for power generation purposes during winter and remained 1.8 ft below BiOp required April 10 elevation. It was at flood control elevation at the end of April of 1220.35 ft. The failure to be at the April 10 required elevation resulted in 105.6 KAF less water in the system. Grand Coulee was drafted from 1218.5 ft on May 13 to 1213.4 ft on May 20, as State and Federal Salmon Managers requested flow targets at McNary. The flow target was not met during the entire period because of draft limitations of 1 ft/day at Grand Coulee. Refill to elevation of 1289.5 ft was achieved on July 12. Failure to refill Coulee through June 30 resulted in 433 KAF less water in the system for summer migrants.

Libby commenced refill on March 11 with minimum outflow of 4 kcfs in order to meet spring refill and sturgeon pulse flow requirements by the end of June. Libby continued a refill operation with minimum outflow of 4 kcfs until the sturgeon flow pulse was implemented in June, after it was operated with an outflow of 8 kcfs for bull trout. The Libby operation resulted in delayed refill, although the average monthly inflows at Libby were in the range of 103% to 139% of average during the March-July period, with exception of May. The reservoir was not refilled until August 9, because of flood control and other operations requirements. This operation shifted 1147.5 KAF from the summer migration period to the spring migration period.

Dworshak reservoir was 1.8 ft above required BiOp elevation on April 20 due to local snow melt and high inflows in excess of the hydraulic capacity of the project, resulting in 16.3 KAF additional water in the reservoir than required by BiOp. This was due to the inability of COE to draft the reservoir at rates higher than 14 kcfs without violating the 110% limit of total dissolved gas (TDG) in the tailrace below dam. The end of April elevation was 1453.4 ft, which was 8.4 ft higher than the required end of April Flood Control Elevation. Total 76.9 KAF of water remained in the reservoir above the volume required by flood control operations at the end of April. There was the potential option to provide an additional 300 to 400 KAF of water, if the flood control elevation had been relaxed to 1477 ft or 1487 ft at the end of March. This water could have been evacuated during April, significantly improving April flows. Average inflow during April 1999 was 10.4 kcfs, or 87.6% of average, with 58% of average precipitation. Average outflow was 10.8 kcfs. Evacuation of an additional 400 KAF during April would have been possible with spill at the project. Existing COE flood control studies indicate that there is no significant local flood control damage for peak flows under 115 kcfs at Spalding (Columbia River Basin, System Flood Control Review, Preliminary Analysis Report-USA, COE, February 1997, 1.0 Purpose and Scope, Pg. 4). Historical data shows that peak flows have not occurred earlier than the third week of April (4/21 1965 and 4/19/1928) for the period of 1928-1978. This indicates that additional volume could have been stored to augment flows without substantial risk. The draft of Dworshak reservoir was constrained to less than 14 kcfs to avoid exceeding the state water quality standard of 110% dissolved gas below the project. As a result migration flow targets were not met at Lower Granite. This operation combined with a 7% decline in May Final Runoff Volume Forecast and April conservative flood control drafts following April Runoff volume decrease of 7% resulted in delay of spring refill to July 15 from the June 30 target. The reservoir was refilled only to elevation of 1593.4 ft, instead of BiOp elevation of 1600 ft. These operations resulted in 225.1 KAF of water shifted from summer into spring. The failure to refill the reservoir resulted in 123 KAF less water for summer flow augmentation at Lower Granite.

Brownlee was 4.7 ft above required April 20 elevation, resulting in 72.9 KAF of water being stored above BiOp required volume in the reservoir. The reservoir was 14.5 ft above required end of April flood control elevation, or 102.6 KAF above the end of April required volume for flood control operations. The additional reservoir storage occurred because reservoir inflows increased as the result of above average (136% of normal) precipitation in the Upper and Mid Snake areas. The higher inflows coupled with the Idaho Power Company refusal to spill, to increase outflow through the Hells Canyon Complex projects resulted in higher than anticipated elevations. Brownlee continued to refill during May 4-19 period in spite of Salmon Managers requests to meet flow targets at Lower Granite during May 4-19. IPCO declined to pass inflow at Brownlee in order to avoid additional spilling at its projects. The difference between actual inflow and actual outflow was in the range of 1 kcfs to 12 kcfs during the requested period. Brownlee was refilled as required by BiOp, to 2076.4 ft by June 29.

Reservoirs refill for the summer migration extended well into the July through August period. A summary of June 30 actual reservoir elevations and reservoir elevations anticipated by Biological Opinion 1995 and Supplemental 1998 Biological Opinion is presented in Table 7.

TABLE 7. Reservoir Elevations at June 30.

Project	Normal Full Pool Elevation [ft]	Pool Elevation on June 30 [ft]	Date of Highest Pool Elevation
Libby	2459	2432.94	2458.97 ft as of August 9
Hungry Horse	3560	3550.97	3560.57 ft as of July 25
Grand Coulee	1290	1284.10	1289.50 ft as of July 17
Brownlee	2077	2076.08	2076.4 ft as of June 29
Dworshak	1600	1580.59	1593.41 ft as of July 15

The failure to refill reservoirs in the Upper Columbia by the end of June resulted in 1803

KAF less water in July-August period at McNary. There was a total volume of 2027.6 KAF less in the Upper Columbia and Snake River reservoirs at the end of June than required by BiOp. This was due to delayed or insufficient refill. A brief summary of individual reservoir operations follows.

The Opinions also identified that water for summer augmentation has to be released from reservoirs by August 31. A summary of required BiOp elevations on August 31 and actual reservoir elevations is included in Table 8.

TABLE 8. Reservoir Elevations at August 31.

Project	Opinion Summer Reservoir Draft Limit [ft]	Actual Elevation on August 31 [ft]
Libby	2439	2455.63
Hungry Horse	3540	3554.3
Grand Coulee	1280	1286.4
Brownlee	2059	2045.3
Dworshak	1520	1526.59

Favorable weather conditions maintained summer flow levels and delayed the decrease in flows at McNary through the end of summer. The flows did not decrease below 157.2 kcfs until August 30. High inflows in August from the Canadian part of the Upper Columbia eliminated the necessity for drafting Libby, Hungry Horse and Grand Coulee to BiOp recommended elevations, as Salmon Managers requested operation of the system to meet minimum flow requirement of 200 kcfs on a weekly basis at McNary during the summer. The 200 kcfs flow at McNary was managed as a cap on flow volumes. Volumes were available to increase flows, if augmentation had been provided along with precipitation. A total of 1530.6 KAF from the Upper Columbia remained in the reservoirs from the summer augmentation on August 31. Fishery Agencies specified flows at McNary in their system operational request to federal regulating agencies for late fall chinook migration in September. Reservoirs were managed primarily for power generation purposes during September, so that flows were not met as requested for fish during the third week of September, and were exceeded during the last week of September. Specific August and September operations follow:

Libby was drafted only to 2455.63 ft at the end of August, as inflow at Libby was 151% of average in August. A total 692 KAF of augmentation volume remained in the reservoir on August 31. Rather than provided for summer migrants Libby was drafted through September to 2449.12 ft.

Hungry Horse was drafted only to 3554.3 ft at the end of August rather than the BiOp target of 3540 ft for August 31. Total 339.8 KAF remained in the reservoir on August 31. The reservoir was drafted through September to 3544.78 ft.

Grand Coulee was drafted to 1286.4 ft at the end of August and to 1285.3 ft at the end of September instead of 1280 ft at the end of August as intended in the BiOp. Total 498.8 KAF remained in the reservoir on August 31, which could have been provided to summer migrants. Modification in the reservoir management during September, which included drafting of the reservoir to elevation of 1285 ft through the end of third week of September, and passing inflow during the fourth week of September 1999, occurred to provide some protection for fall chinook in the Lower Columbia. The operation of Grand Coulee to provide protection to spawning fall chinook below Bonneville Dam was limited to shaping flow. Additional volume draft was not included.

Salmon Managers requested draft of the remaining flow augmentation volumes from the reservoirs later in the season, during the fall 1999, to improve conditions for fall chinook and chum spawners below Bonneville Dam in the area of Ives, Hamilton and Pierce Islands.

Drafting of the reservoirs for Lower Snake River flow augmentation commenced on July 1. The State and Federal Salmon Managers requested a weekly flow target of 57 kcfs through July 11 and daily flow target of 55 kcfs through July 25 utilizing Brownlee water first and then Dworshak if needed for flow augmentation at Lower Granite Dam. The major constraints to meeting required flows were the limitation in hydraulic capacity of the Hells Canyon Dam, the refusal to spill through the Hells Canyon Complex, desire of Idaho State to maintain higher elevations of the Dworshak reservoir for recreational purposes and the limit of 110% of total dissolved gas saturation in the tailrace of the dam. Issuance of total dissolved gas waiver from the State of Idaho became the major limitation in drafting Dworshak at rates higher than 14 kcfs, limiting shaping of flows at Lower Granite for the peak of the fall chinook migration. A summary of reservoir operations follows.

Brownlee was drafted to 2052.14 ft for delivery of 237 KAF of Upper Snake augmentation water, for the USBR portion of the Payette augmentation of 76 KAF through the end of July.

The delivery rate was constrained to 22 kcfs; the hydraulic capacity of Hells Canyon Dam. This constraint was due to planned turbine maintenance by IPCo. The reservoir was drafted to elevation of 2045.6 ft by the end of August and to elevation 2039 ft by the end of September because of the favorable power market conditions.

The outflow limitation of Dworshak reservoir was a disputed issue among State and Federal agencies during the summer operating season of 1999. Salmon Managers requested the drafting of Dworshak when flows at Lower Granite dropped below 55 kcfs. Dworshak flows were increased gradually starting on July 15 to gradually introduce 50-degree F water downstream. The objective of reducing water temperature downstream is balanced with the needs of naturally spawning fish in the Clearwater River and rearing conditions required at Dworshak National Fish Hatchery. The COE was increasing flows in the period of July 15-19 with non-uniform ramping rates in order to maintain higher reservoir elevations during the weekend. Between July 19 and 30, outflows were managed to a total dissolved gas standard of 110% for the Clearwater River. On July 31, EPA issued a dissolved gas waiver on behalf of Nez Pierce tribe to allow management to a dissolved gas level of 120%. The Salmon Managers requested water temperatures of 47 degrees for the Dworshak outflow. The reservoir was drafted with peaking outflows of 19 kcfs through August 8. Fishery Agencies with exception of CRITFC and IDFG requested drafting at the same rate of 19 kcfs through August 15 and to 12.6 kcfs for the week ending August 22, reaching elevation of 1520 ft and improving flows at Lower Granite at the peak of the migration. The request was denied, because EPA did not agree to issue the extension of the TDG waiver for the requested period. Instead, project outflows were gradually decreased from 19 kcfs to 10 kcfs on August 23. Dworshak was drafted to elevation of 1526.6 ft, instead of the BiOp required elevation of 1520 ft at the end of August. This resulted in 87.1 KAF of summer augmentation water shifted into September. On August 31 Salmon Managers requested water released from Dworshak to be 50 degrees F to facilitate Dworshak hatchery needs. The reservoir was operated in agreement with Fishery Agencies to elevation of 1521.5 ft on September 5 for augmentation of late migrating fall chinook. The reservoir finally reached an elevation of 1520 ft on September 14. Dworshak passed inflow through the end of September.

More detailed reservoir management data are included in Appendix A.

Canadian Reservoirs: Columbia River Operations conducted under the Columbia River Treaty and the Non Treaty storage agreement directly impact salmon migration conditions. The operation of Canadian reservoirs under these two agreements can potentially improve or limit migration protection provided for salmon. Canadian reservoirs (Mica, Arrow and Duncan) and US reservoir (Libby) are operated under US-Canada Treaty established in 1964. These reservoirs were built under the auspices of the Columbia River Treaty and comprise almost half of the storage of 15.5 MAF in the Columbia River System. An additional 5 MAF of storage behind Mica Dam is not included in Treaty Operations and is referred to, as "Non Treaty" Storage. The 1995 BiOp and the 1998 Supplemental BiOp do not specify any special operation of these reservoirs for the purposes of anadromous fish migration improvement in water years when the 95% confidence January-July unregulated volume runoff forecast at The Dalles is above 90 MAF. The 1999 runoff volume forecast was above 90 MAF, and no additional storage for flow augmentation measures are included in the BiOp for this runoff volume. However, the 1995 BiOp includes the requirement that BPA negotiate with BC Hydro and the other US Non Treaty Storage agreement signatories to mutually store water in NTS during the spring for subsequent release in July and August for flow enhancement, as long as operational forecasts indicate that water stored in the spring can be released in July and August. This term is reiterated in the Supplemental BiOp of 1998 and in practice limits BPA's NTS release rights in the summer only to water it stores in the spring. Although there is potential to improve fish passage conditions by utilizing additional non-treaty storage operations, there is a constraint in the Biological Opinion. The Biological Opinion states that non-power objectives must be addressed in a "revenue-neutral" manner for BPA.

Currently the FCRPS has been operated according to the Detailed Operating Plan for Columbia River Treaty System for August 1, 1998 through 31 July 1999. Under the Detailed Operating Plan, the entities empowered the Columbia River Treaty Operating Committee to prepare and implement changes to the DOP that produce additional mutually beneficial results, related to operation of Treaty Storage for non power uses.

Current operations for non power purposes include meeting Canadian white fish, trout spawning and Arrow recreational level enhancement obligations, and meeting US Vernita Bar obligations for the period of January 1, 1999 through July 31, 1999 through the storage and release of water above and/or below Treaty Storage Regulation levels at Arrow. There were no specific obligations related to chum operations to protect chum or fall chinook salmon below Bonneville Dam for the period of October 1998 through April 1999. Following is a summary of the operations of Canadian reservoirs.

- **The whitefish operation which took place in December 98 through January 99 period below Arrow dam limits actual outflows below Arrow for whitefish spawning. BPA provisionally drafted total 340 ksfd in advance during the September through December 1998 period for whitefish spawning. This resulted in a monthly draft: 150 ksfd in September, 10 ksfd in October, 150 ksfd in November and 30 ksfd in December. Flows for whitefish spawning had been restricted to a range of 36 to 41.7 kcfs during December 11-31 based on historical record flows. After the January Final forecast was issued, flows increased to 47 kcfs through January 17 and to 52 kcfs through January 27. The whitefish provisional draft of 300 ksfd was returned during this period, and 40 ksfd was returned at the beginning of March.**
- **Whitefish water could be used for improving flows below Bonneville, if the major volume of water was released in October 1998, instead in September 1998. This could be a useful resource in protecting natural spawning areas below Bonneville Dam. Releases were shaped primarily for power generation purposes.**
- **Flows below Arrow were restricted to 15-30 kcfs between March 28-June 30 to limit the extent of trout spawning below Arrow Dam. At that time, in May 11-26, flows at McNary were below the required flow target. There is no upper limit restriction for flows at Arrow for trout spawning in May, and if the runoff volume forecast was revisited it would be possible to increase flows and meet the flow target at McNary, maintaining higher elevations below Arrow dam through the end of spawning period. It is important to note that Arrow flows are not the only source of water for preserving elevations at the spawning site, high flows from Kootenai River below the dam with its backwater effect can contribute to the Arrow trout needs.**
- **The Arrow trout operation is intended to limit available habitat and spawning at higher elevations. In 1999, a less conservative operation, based upon the run-off volume forecast could have provided and maintained more habitat for trout while meeting the flow target at McNary Dam on a weekly basis. Flows could be increased at the beginning of the period of the decreasing flows in the second week of May in the system, in anticipation of the flows lower than BiOp target at McNary. (The most recent experience of May 2000 is showing that BPA is increasing flows below Arrow dam in the cases of low flows and high**

power demands at the market, without anticipation of keeping those flows through the end of spawning period).

- **The US Entity NTS releases were implemented primarily to meet power generation interests. There was potential opportunity to shape NTS releases to address fish needs. During Water Year 99 dominant releases were in October-December period, for the purposes of the power generation but not sufficient for the needs of chum salmon spawning. Additional releases of Non Treaty storage in October through November period, with refilling activity in December would shape the flows according to fish needs, instead of power generation demands. A total of 217.2 ksfd was released during October through November period, while only 21.03 ksfd was released in December. Higher releases of Non Treaty storage in October through November period by approximately 260 ksfd and better shaping of the daily flows would provide required flows for chum salmon. Part of the anticipated December flood control releases, with some assumption of the risk involved in it, may refill the Non Treaty storage by the end of December. This operation would assume lower flows in December, when the power market is favorable. Major refill of the NTS occurred during January, a total 186.5 ksfd, and during the March through June period, of total 402.5 ksfd was stored. Significant refill of 140 ksfd occurred during May, when flows at McNary were below the required flow target. NTS was refilled to 92% of full by the end of June. In spite of agreement for summer releases of spring storage only 157.7 ksfd was released in July. During August, because of the high inflows, Arrow stored an additional 50 ksfd. In September, NTS released only 65.5 ksfd. At the end of September the NTS was at 71% of full.**
- **Although, summer flows were high at McNary, there was the potential of improving flows at McNary with alternative management of Duncan reservoir and Kootenai Lake in the July-August period. Treaty operations assume that Duncan would be refilled by the end of July in a water year like 1999 with the project passing inflow in August. At the same time, Kootenai Lake is usually held at elevation of 1745.4 ft in July and drafted to elevation of 1743.7 ft by the end of August as required by International Joint Commission Order. A modified operation may have improved August flows by passing inflows at Duncan in July and at the same time Kootenai Lake refills to International Commission allowed elevation of about 1747-1748 ft and then draft that volume later in August. This**

operation might improve August flows by 300-400 KAF, shifting July water into August and improving power generation at Kootenai Canal Project during August, by avoiding spill in July. This operation is also in agreement with provisions of Principles for Changes to Arrow Treaty Operation for Non Power Uses-Article D.

Upper Snake Bureau of Reclamation reservoirs: Spring flood control operations at Jackson Lake and Palisades resulted in the refill of the reservoirs in April, instead of March. Failure to refill reservoirs in March, with subsequent draft in April, resulted in 9.3 kcfs less outflow in April at Lower Granite. The US Bureau of Reclamation (USBR) delivered 427 KAF as required by the Biological Opinion from mid-Snake and upper Snake reservoirs, during the July-August period, similar to 1996-1998. A total of 41 KAF of water was delivered from the Boise system; 145 KAF from the Payette River; 223 KAF from the Upper Snake; and 18 KAF from Skyline Farms. Rates of delivery did not exceed hydraulic capacity of the Milner plant of 1.5 kcfs from the Upper Snake reservoirs. This effectively limits the ability to shape these flows. Flow was 300 to 500 cfs above irrigation flow from Lucky Peak and 900-1100 cfs above irrigation flow from Cascade and Deadwood. USBR continued to release irrigation surplus water from the Upper Snake reservoirs during first two weeks of September at rate of 1.2 to 1.5 kcfs. IPCo delivered their portion of 45 KAF of flood control water from American Falls at rate of 1.2 kcfs, not exceeding the hydraulic capacity of Lower Salmon Falls from the second week of September through the first week of October 1999.

The rate of delivery of augmentation water from Upper Snake reservoirs is constrained by the hydraulic capacity of the Milner and Lower Salmon plants. The ability to pass flow augmentation volume by these projects and shaping the flows to the fish migration is constrained by these FERC licensed projects. It is an important factor in shaping water during summer depending of status of migration.

3. Flows

Spring and summer migration period flow targets were established according to terms identified by NMFS in the Opinion of 1995 and the 1998 Supplemental Steelhead Biological Opinion. Spring and summer flow objectives at Lower Granite are based on the April final runoff volume forecast. Based upon the runoff volume predicted in the April Final Runoff Volume Forecast, a sliding scale of flow targets was developed by a linear interpolation between 85 kcfs and 100 kcfs for the spring flow target and between 50 kcfs and 55 kcfs for summer flow target. The spring flow objective at McNary was based on the January-July runoff volume forecast for the Dalles and another sliding scale determined by linear interpolation between 220 kcfs and 260 kcfs. The summer BiOp flow target is provisionally determined to be 200 kcfs based on the best available biological information at that time for reducing mortality for subyearling chinook migrating through the lower Columbia. The Supplemental Biological Opinion of 1998 established a flow objective for the Mid Columbia reach of 135 kcfs. The resulting seasonal flow targets and seasonal range are shown in Table 9.

TABLE 9. Flow targets at Lower Granite, McNary and Priest Rapids.

Location	Period	Flow Target [kcfs]	Observed Seasonal Average Flow [kcfs]	Observed Seasonal Range in Daily Average [kcfs]
Snake River at Lower Granite	April 10-June 20	100	117.0	72.8-187.5
Columbia River at Priest Rapids	April 10-June 30	135	169.6	96.7-220.2
Columbia River at McNary	April 20-June 30	260	303.6	237.8-369.8
Snake River at Lower Granite	June 21-August 31	54	56.0	27.6-82.5
Columbia River at McNary	July 1-August 31	200	228.2	157.2-295.5

In order to avoid severe drop in flows on weekends, the 1995 Biological Opinion recommended that McNary's daily average flows on weekends not drop below 80% of the preceding week's average weekday outflow. This target operation was successfully implemented through the whole season, except on August 22, when daily flow was 73.2% of the five day average.

Seasonal flow targets were exceeded at all projects. However, weekly flow targets were not met during the entire spring-summer season at all three projects. At Priest Rapids the flow target was not met during the first week of migration season because of the previous reservoir draft for flood control and maintenance purposes. At McNary the daily flow target was not met during May 10-16. Also, daily McNary flow fluctuated between 157.2 kcfs-215.7 kcfs during August 21-31, due to the decision by federal regulators to operate reservoirs not to exceed 200 kcfs on a weekly basis. This effectively managed the flow target as maximum, not as a minimum. This is contrary to previous interpretations of the Opinion. The spring flow target was not met at Lower Granite during the second week of April and the first three weeks in May because of previous conservative drafting of the reservoirs for flood control, low inflows at that time, cold temperatures and delayed snowmelt later in the spring. The summer flow target at Lower Granite was not met during the second half of July and August because of the insufficient summer flow augmentation.

Figure 3, Figure 4, and Figure 5 illustrate the daily average flow, compared to the NMFS Opinion flow targets at Lower Granite, Priest Rapids, and McNary.

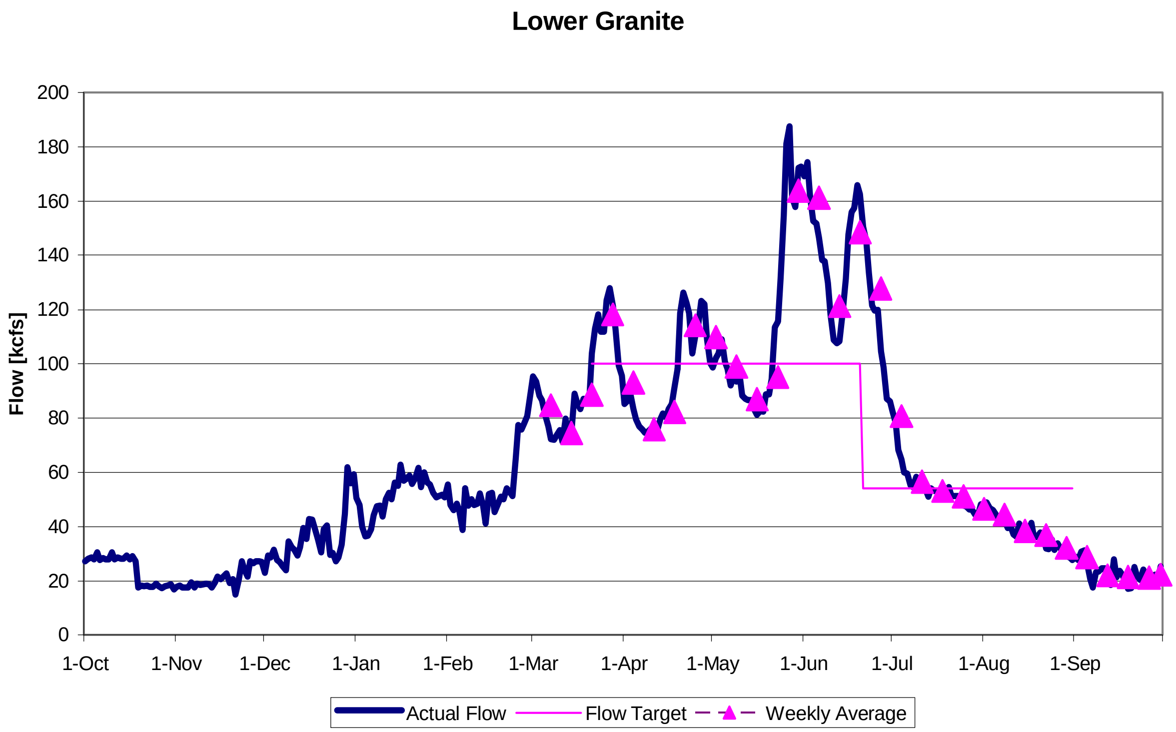


FIGURE 3. Target flows versus actual flows at Lower Granite.

FIGURE 4. Target flows versus actual flows at Priest Rapids.

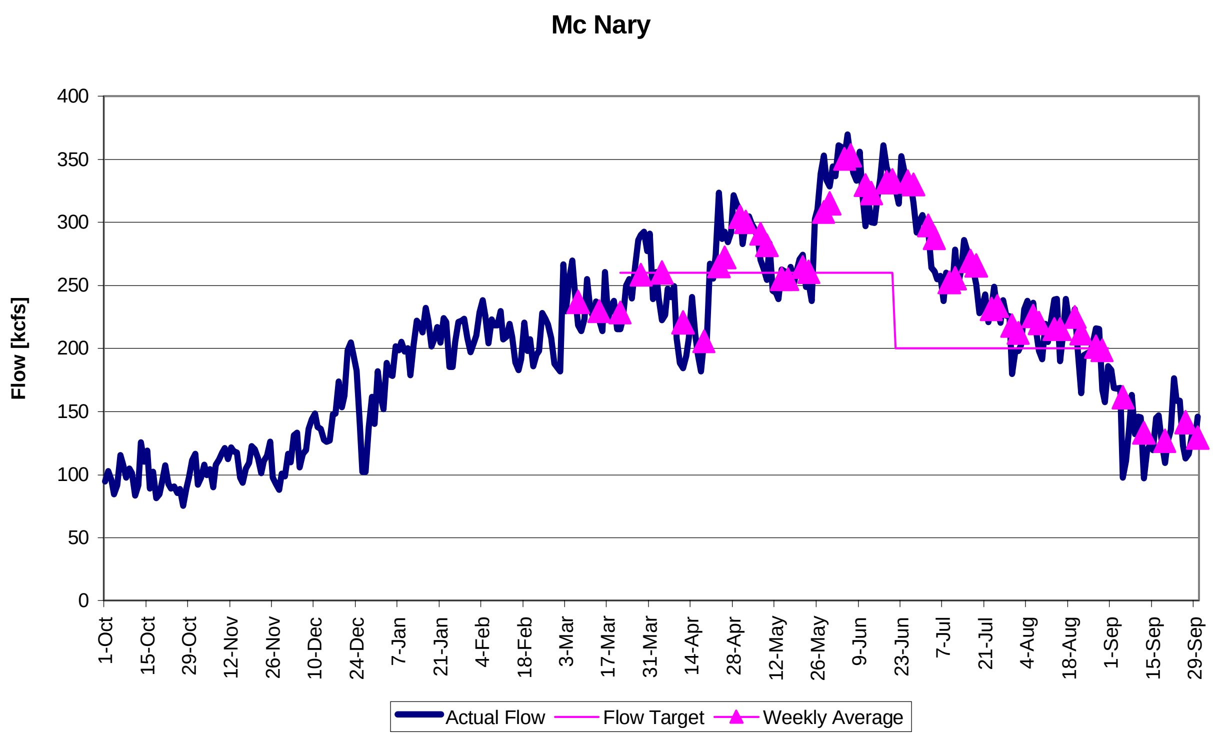


FIGURE 5. Target flows versus actual flows at Lower Granite.

4. Detailed Project Operations

The following discussion describes specific operations through the passage season at major river reference points. These sites are the subject of system operations requests and management points for passage operations and requests. Individual storage reservoir operations that resulted in the flow conditions at the run-of river projects are discussed in detail in Appendix A.

Lower Granite

Spring/Summer Operations: The 1995 Biological Opinion spring flow target at Lower Granite was established at 100 kcfs, the same as the 1996 and 1997 spring flow targets. The actual 1999 seasonal spring (April 10-June 20) flow average was 117 kcfs with wide daily flow variations in the range of 72.8 kcfs-187.5 kcfs. Daily average flows fluctuated widely due to seasonal variations in the natural flow and due to daily load following electricity demands. The summary of weekly average flows and ranges is given in the Table 10.

TABLE 10. Lower Granite Dam: Spring 1999 Weekly Average Flows

Seasonal Average (4/10-6/20) =117.0 kcfs		
Week ending	**Weekly Average [kcfs]**	**Range [kcfs]**
11 April	75.8	72.8-79.6
18 April	82.3	75.3-91.0
25 April	114.1	98.3-126.3
2 May	109.8	98.7-123.2
9 May	99.0	92.0-109.1
16 May	86.9	81.1-95.8
23 May	95.2	82.3-115.7
30 May	163.7	131.4-187.5
6 June	161.2	146.5-174.3
13 June	121.2	107.6-138.3
20 June	148.5	118.8-165.8

Flows in the first week of migration were below the spring flow target due to cold weather and conservative drafting of reservoirs for flood control. Reservoirs were on flood control elevations in mid-April and low precipitation at that time of the year resulted in low flows in the Snake River. Redistribution of the flood control draft (approximately 300-400 KAF) from the end of March period into early April period could have improved early spring flows. However, the COE would not consider any modification in flood control operations.

Flows continued to be low due to delayed snowmelt and low precipitation during the peak of the spring/summer chinook, steelhead and sockeye migration, through May 3-22. Initially, the COE was unable to reliably model the operations in advance. The COE continued to use a normal weather pattern assumptions in its flow forecasting models in spite of the actual dominant cold weather pattern in the basin, which was forecasted and actually occurring. The resulting projected flows were above flow target, but those flows failed to materialize. In reality recognizing the actual situation, state and federal salmon managers requested drafting of Dworshak and passing inflow at Brownlee to maintain flows at the minimum requested flow targets. The COE agreed to draft Dworshak at rate to avoid spilling over allowed Total Dissolved Gas (TDG) content of 110% in the tailrace. In order to draft at a higher rate it was necessary that State of Idaho and Nez Pierce Tribe issue TDG waivers to allow TDG content of 120% in the tailrace. NMFS received TDG waivers from State of Idaho only and the flow request was denied. At the same time, Brownlee reservoir was not passing inflow because of the NMFS concern on the effects of TDG on emerging fall chinook below the Hells Canyon complex and IPCo intention to avoid spilling. If Dworshak was drafted at higher rate, and Brownlee was operated to pass inflow, flows might have been higher, in the range of 5-15 kcfs, and the flow target would have been met.

Peak flow of 187.5 kcfs of the spring migration season occurred on May 27. The summer flow target at Lower Granite was established at 54 kcfs. It was met on a seasonal basis, but not on a weekly basis. The actual average seasonal flow was 56.01 kcfs. As has occurred in past years flows in July 16 through August 31 period were well below the target flow. Flows decreased from 150.6 kcfs on June 21 to 27.6 kcfs on August 31. A summary of the weekly average flows during the summer season is given in the Table 11.

TABLE 11. Lower Granite Dam: Summer 1999 weekly average flows.

Seasonal Average (6/21-8/30)=56.01 kcfs		
Week Ending	**Weekly Average [kcfs]**	**Range [kcfs]**
27 June	127.8	104.6-150.6
4 July	80.7	64.7-98.6
11 July	56.6	53.3-60.0
18 July	53.2	51.1-54.4
25 July	51.2	47.8-54.6
1 August	46.5	44.4-48.3
8 August	44.5	41.5-48.8
15 August	38.4	36.3-41.1
22 August	36.9	32.0-41.3
29 August	32.2	29.2-33.9
5 September	28.70	26.5-31.2
12 September	22.02	17.6-24.6
19 September	21.44	17.1-27.8
26 September	21.21	17.3-25.2
30 September	22.30	20.1-22.3

Salmon Managers requested that flows be held at a level of 57 kcfs through July 11 and at 55 kcfs through July 25 as migration of fall chinook progressed. The State of Idaho maintained its policy that recreational use of Dworshak was a higher priority than migration needs of listed Snake River fall chinook. Drafting of Dworshak reservoir was delayed until July 15, and then it was not drafted at a sufficient rate to achieve the requested flow of 55 kcfs.

Following the peak of the fall chinook migration, the salmon managers with exception of IDFG and CRITFC, requested drafting Dworshak reservoir at rate of 19 kcfs in order to maintain weekly average of 54 kcfs from July 29 through August 8. However, the flow target was not met in part because of the delayed draft of Dworshak reservoir through July 31, pending the issuance of the TDG waiver and because natural flows decreased to a level that Dworshak flow augmentation alone was not sufficient to meet the flow target. The Salmon Managers requested continuation of the Dworshak draft at the rate of 19 kcfs through August 15, following the peak of the migration, and then at rate of 15 kcfs through August 22, but the Environmental Protection Agency denied extension of the waiver on TDG levels of 120% after August 8. EPA basically determined the flows at Lower Granite with TDG waiver at Dworshak for the period of August 9-22, allowing TDG levels only for gradually decreasing flows to 10 kcfs and therefore not meeting migration targets.

State and federal salmon managers requested the release of a portion of Dworshak augmentation water of 79 KAF in the period of September 1 through 14 in order to benefit the late fall chinook juvenile outmigration and adult migration in the Lower Snake. Flows at Lower Granite rapidly decreased to 17.1 kcfs until September 19 and continued to fluctuate between 17.1 kcfs and 25.3 kcfs through the end of September.

A comparison of the 1994 through 1999 spring and summer monthly average flows is given in Table 12. It shows that 1999 migration at Snake River was similar to 1996 with 10% lower spring flows than in spring of 1996.

TABLE 12. Lower Granite Dam: Spring/Summer 1994-1999 monthly average flows.

MONTH	FLOW [kcfs]					
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
AprilAverage	48.7	61.1	114.5	122.0	65.5	93.9
MayAverage	77.0	108.9	127.2	169.0	141.01	112.5
JuneAverage	38.0	114.8	144.9	161.3	113.6	133.7
JulyAverage	39.2	60.8	54.4	68.9	61.7	54.7
AugustAverage	12.9	37.2	37.2	46.1	32.9	37.7
Spring Opinion Flow Target	85.0	95.0	100.0	100.0	90.0	100.0
Actual Spring Average	61.4	101.1	138.3	162.5	115.6	117.0
Summer Opinion Flow Target	50.0	52.0	53.5	55.0	50.6	54.0
Actual Summer Average	26.3	55.3	52.7	66.3	53.2	56.01

Priest Rapids

Fall/Winter Operations: The Vernita Bar agreement established the main criteria for system operations in Mid Columbia during October 18 through November 25, 1998. Minimum required daily average flows for adult spawning fall chinook below Priest Rapids were 65 kcfs. Average daily fluctuations in that period were between 58.9 kcfs on November 15 and 114.9 kcfs on November 19. The summary of the monthly averages with daily average range is given in Table 13.

TABLE 13. Priest Rapids Dam: Fall/Winter 1998/99 monthly averages.

Month	Monthly Average [kcfs]	Range [kcfs]
October	75.04	48.0-99.7
November	85.2	48.0-114.9
December	107.8	61.4-178.8
January	141.1	81.2-162.8
February	148.0	76.1-179.0
March	140.3	96.3-159.4

Spring/Summer Operations: The 1998 Supplemental Biological Opinion established spring flow targets at Priest Rapids of 135 kcfs during April 10 through June 30 period. The flow target was met on a seasonal basis, with an average of 169.6 kcfs. Weekly averages ranged from 116.1 kcfs during second week of April to 200.6 kcfs during second week of June. A summary of the spring weekly averages and their ranges is given in the Table 14.

TABLE 14. Priest Rapids Dam: Spring 1999 weekly flows.

Seasonal Average [4/10-6/30]=169.6 kcfs		
Week Ending	**Flow Average [kcfs]**	**Range [kcfs]**
18 April	116.1	96.7-134.0
25 April	154.3	128.8-177.6
2 May	185.7	168.4-202.2
9 May	175.8	152.4-196.1
16 May	161.7	146.2-179.9
23 May	155.0	111.0-180.7
30 May	159.9	133.7-179.4
6 June	191.1	162.1-220.2
13 June	200.6	166.6-217.9
20 June	177.0	173.4-192.4
27 June	192.5	152.8-214.4

The Salmon Managers requested limitations in hourly flow fluctuations for the period of March 21-31 because of the potential stranding of the emerging fry from redds below Priest Rapids. The highest fluctuations were on March 21, when flows decreased from 149.9 kcfs at 12 p.m. to 64.8 kcfs at 3 p.m. and remained at that level for 5 hours. The stranding issue was a significant concern at Priest Rapids during spring 1999 season, but federal regulators would not assume responsibility for operations to limit hourly and daily fluctuations, indicating that responsibility for operations on an hourly basis was maintained by Grand County Public Utility District. An agreement was reached among federal regulators and Public Utility District to operate Priest Rapids within a 40 kcfs flow range during the spring season.

At the beginning of the migration season, April 14-21 flows were below the requested target flows, due to cold and dry weather conditions through the region. The refill of Hungry Horse and the draft limitation of 1 ft/day at Grand Coulee also contributed to the lower than target flows at McNary during this period.

Summer weekly averages were in the range of 157.3 kcfs-202.8 kcfs. August flows remained higher than normal due to high inflows from Upper Columbia basin. A summary of the weekly averages and their ranges is given in the Table 15.

TABLE 15. Priest Rapids Dam: Summer weekly averages.

Seasonal Average [7/1-8/31]= 228.2 kcfs		
Week Ending	**Weekly Average [kcfs]**	**Range [kcfs]**
4 July	196.1	181.2-211.2
11 July	186.2	174.8-202.8
18 July	202.8	164.6-228.7
25 July	182.2	151.6-194.9
1 August	157.3	128.3-191.9
8 August	160.0	137.3-182.4
15 August	173.5	139.5-195.3
22 August	163.4	128.6-182.7
29 August	158.5	138.4-171.9
5 September	129.0	85.9-167.6
12 September	111.4	77.0-140.3
19 September	106.4	92.1-121.9
26 September	115.6	83.6-146.6
30 September	120.2	110.8-132.2

The average spring and summer monthly flows in comparison with the same period of 1992 through 1999 are given in the Table 16. The monthly average distribution during the spring/ summer season of 1999 resembles what occurred in the spring of 1998 and the summer of 1996.

TABLE 16. Priest Rapids Dam: Spring/Summer monthly average flows in 1994-1999.

Month	Average Flow [kcfs]					
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
April	92.4	101.8	194.5	179.8	86.3	145.4
May	124.5	136.5	216.3	279.0	175.5	164.3
June	154.1	154.8	241.3	328.0	175.3	192.3
July	110.5	131.5	189.6	201.6	133.7	185.2
August	80.4	101.5	148.2	151.9	113.2	162.02

McNary

Spring/Summer Operations: The 1995 Opinion established a spring flow target of 260 kcfs at McNary Dam based on the May Final January through July Runoff Volume forecast at The Dalles. The flow target was exceeded on the seasonal basis with the seasonal average of 303.6 kcfs. The flow target was not met on a weekly basis during the week of May 10 through 16. Cold weather, delayed snowmelt, low precipitation and reduced inflow from Canadian reservoirs due to trout spawning limitations resulted in low inflows from Mid Columbia basin, when Canadian reservoirs outflow was restricted for trout spawning below Arrow.

The peak daily flow of 369.4 kcfs was recorded on June 5. Peak flows were in the range of 305.5 kcfs to 369.4 kcfs. A summary of the weekly averages is given in the Table 17.

TABLE 17. McNary: Spring 1999 weekly average flows.

Seasonal Average (4/20-6/30)=303.6 kcfs		
Week Ending	**Weekly Average [kcfs]**	**Range [kcfs]**
25 April	272.1	205.0-323.3
2 May	300.4	282.5-321.1
9 May	281.7	254.4-304.6
16 May	254.9	239.2-283.5
23 May	260.6	249.2-274.0
30 May	314.9	237.8-352.8
6 June	353.0	336.4-369.4
13 June	323.2	297.0-355.8
20 June	333.2	299.7-360.7
27 June	329.9	314.6-352.3
28-30 June	294.5	292.1-305.5

The summer flow target was met and exceeded on a seasonal and weekly basis, except in the last week of August, as illustrated in Table 18. The highest summer daily flow of 295.5 kcfs occurred on July 1, decreasing slowly to 237.6 kcfs on August 4 and maintaining that level through August 13. The lowest daily flow of 157.2 kcfs was on August 30. This year high summer flows occurred due to late snowmelt of Canadian snowpack and high outflows from Canadian reservoirs in July and August. Above average August precipitation, 131% of normal, for the Columbia River above Grand Coulee, contributed to the higher than normal August flows.

TABLE 18. McNary: Summer 1999 weekly average flows.

Seasonal Average (7/1-8/31)= 228.2 kcfs		
1-4 July	278.6	261.0-295.5
11 July	255.6	237.8-277.9
18 July	265.6	250.8-285.9
25 July	233.5	221.1-248.6
1 August	212.3	180.0-238.2
8 August	220.0	198.1-237.6
15 August	215.2	190.2-239.1
22 August	212.2	164.6-239.0
29 August	198.5	167.3-215.7
5 September	161.3	97.7-185.9
12 September	133.07	97.1-163.3
19 September	126.08	109.3-146.9
26 September	141.4	112.7-176.2
30 September	129.2	116.2-145.9

A summary of the monthly average flows for the spring/summer season is given in Table 19. Comparison with previous years monthly average flows shows that 1999 was similar to 1996 with lower flows in spring and higher flows in summer.

TABLE 19. McNary Dam: Spring/summer 1994-1999 monthly average flows.

	FLOW [kcfs]					
	1994	**1995**	**1996**	**1997**	**1998**	**1999**
April Average	142.0	169.0	311.9	313.0	154.9	245.7
May Average	200.3	251.1	338.7	449.2	320.4	281.0
June Average	188.9	277.6	379.2	482.2	292.0	330.97
July Average	146.2	191.2	245.9	274.6	197.2	247.9
August Average	89.8	138.2	183.0	198.3	142.2	208.5
Spring Opinion Flow Target	200.0	249.0	260.0	260.0	228.0	260.0
Actual Spring Average	190.5	253.0	357.1	454.8	287.8	303.6
Summer Opinion Flow Target	150.0	200.0	200.0	200.0	200.0	200.0
Actual Summer Average	118.0	164.7	214.5	237.0	169.7	228.2

The Salmon Managers requested a gradual decrease in flow in September to facilitate the migration of fall chinook in September. Federal Agencies did not agree with this request because it was not included in the BiOp. Reservoirs were operated primarily for power generation purposes. Flows were lower in the first two weeks of September than requested. Libby and Hungry Horse were not drafted at the requested rate and outflow from Canadian reservoirs was limited by turbine capacity to avoid spill at Mica. Flows were higher than requested in the second half of September. Libby and Hungry Horse were drafted at higher rates and Arrow was provisionally drafted 295 ksfd by the end of September in advance for the whitefish operation, which takes place in the December-January period. Resulting flows decreased to 119.5 kcfs on September 15. Flows decreased in the first half of September when the fish migration needed higher flows. Flows increased in the second part of September to 158.2 kcfs on September 23, when the number of fall chinook juvenile migrants was decreasing in the system.

Bonneville

The Fishery Agencies requested a minimum instantaneous discharge of 130 kcfs or greater for fall chinook and chum staging and initiation of spawning at the Ives/Pierce islands area below Bonneville Dam for the period of October 15 through November 15 of 1998. The flow request was increased to 150 kcfs during November 16 through December 31 period for chum salmon spawning. The Fishery Agencies requested a minimum incubation flow, to maintain 0.5 ft of water over the highest identified redd at all times during period of January through April 1999. Daily average flows were fluctuating between 95.5 kcfs and 245.3 kcfs during October 15-December 31 period, as the system was primarily operated for power generation purposes. Meeting the requested flows was possible with an additional draft of Grand Coulee of 3 ft and an additional draft of Libby of 5 ft during this period. Non Treaty Storage releases could have been shaped to provide the needed chum salmon flows. The average flow of 105.5 kcfs was significantly lower than the requested flow of 130 kcfs, in the period of October 15-November 3. Resulting daily average flows were maintained in the range of 125.3 kcfs-127.2 kcfs during November 4-15. Average daily flows fluctuated between 125 kcfs and 245.3 kcfs during November 16-December 7 with an average flow of 133.1 kcfs. The average flow increased to 182.1 kcfs, with daily flows fluctuating between 128.5 kcfs and 245.3 kcfs, from December 8 through the end of December.

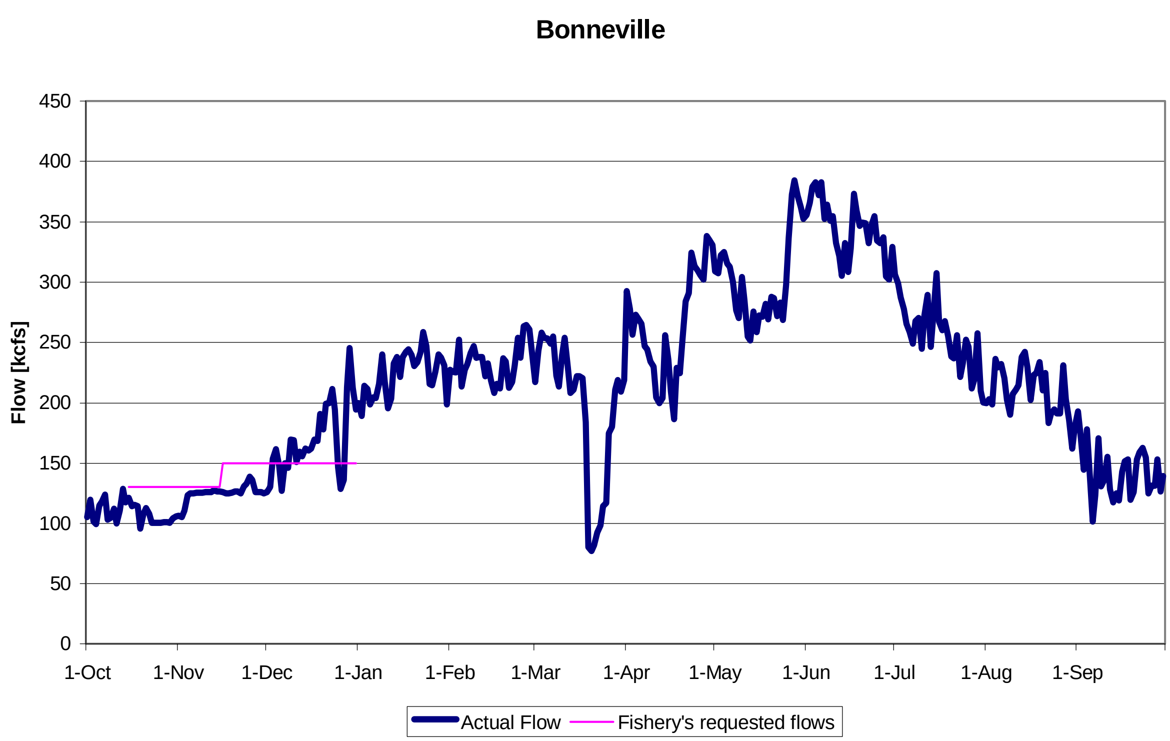


FIGURE 6. Target flows versus actual flows at Bonneville.

C. Conclusions:

- The Spring flow target at Lower Granite was met on seasonal basis, but was not met on a weekly basis during May 3-22.
- For the Columbia and Snake River, 1999, weather conditions were the most significant impact on realization of BiOp measures. 1999 illustrated that the current level of flow augmentation, and BiOp measures alone are not sufficient to meet the summer flow target in average and above average water years. The observed runoff volumes for the January-July period at Lower Granite was 109.8% of normal and at The Dalles was 121.6% of normal. The summer flow target was met on a weekly basis at McNary, while it was not met for almost 6 weeks during the summer period at Lower Granite.
- Summer flow target at Lower Granite was exceeded on seasonal basis, but not on a weekly basis after July 12.
- The failure of the Upper Columbia reservoirs to be at the June 30 full pool elevation, resulted in 1803 KAF water less in storage at the beginning of the summer flow augmentation period.
- Cold, dry weather conditions and a decrease in the April Runoff Volume Forecast characterized the beginning of spring season. A conservative flood control strategy by the COE resulted in overdrafting reservoirs. Drafting occurred for power generation and planned maintenance work resulting in total 397.9 KAF less water in the Upper Columbia reservoirs on April 10, and lower than BiOp target flows at Priest Rapids. This was a result of management decisions by the federal operators.
- The draft rate of 1-1.2 ft/day at Grand Coulee constrained the ability of the system to meet the flow target at McNary from May 10 through 16 during the peak migration period of spring chinook. At the time the only available source of flow augmentation was Grand Coulee, because of flow restrictions below Arrow to limit trout spawning area and delayed refills of Libby and Hungry Horse due to flood control overdraft.
- Libby reservoir was not refilled until August 9 as a result of flood control operations. Commencement of refill on March 11 was too late to refill the reservoir by June 30 as required by the BiOp, although most of the monthly inflows were above average.

Conclusions:

- Hungry Horse was operated to the Integrated Rule Curves defined by the State of Montana. This resulted in refill on July 25 and higher spring flows. A total 222 KAF of water was shifted from summer into spring by this operation.
- Summer flow augmentation was delivered at a rate controlled by the TDG waiver at Dworshak, not to exceed 120% and issued by EPA for a limited number of days-July 31-August 8. This became the controlling factor in meeting the flow target and shaping the flows during the migration period. The issuance of gas waivers was utilized by the State of Idaho to manipulate and limit the provision of migration flows.
- Dworshak releases were successfully used this summer for temperature control at Lower Granite, although ambient temperatures were also favorable.
- Dworshak flood control operations this spring were detrimental for spring flows at Lower Granite. The COE conservatively drafted Dworshak for flood control during early spring, in spite of cold dry weather conditions and a decreased April Final Runoff volume forecast. The COE proceeded with its reservoir management based on SSARR runs, which didn't incorporate the actual colder than normal weather pattern. Runoff failed to materialize as anticipated by the COE, which made it necessary to augment flows for fish at Lower Granite in May.
- Dworshak and Brownlee could have been operated to improve flow augmentation for the spring migration. The State of Idaho refused to issue a total dissolved gas waiver to allow spill at Dworshak and Brownlee. Limiting the outflow level limited the spring flows at Lower Granite Dam.
- The actual USBR operations for the Upper Snake resulted in intensive pre-drafting operations in March, and refill in April, decreasing already low flows at Lower Granite at the beginning of migration. The potential operation of refill in March and drafting in April would have resulted in flows 9.3 kcfs higher at Lower Granite during April.
- Brownlee summer flow augmentation releases were limited to a drafting rate of 1.22 ft/day and hydraulic capacity of the Hells Canyon Dam due to unit maintenance and spill limitations. Maintenance work should be avoided during critical migration periods.
- This was the second year that flows were requested for protection of chum and fall chinook during their October through April spawning and incubation and emergence period. October through November flows were lower than requested, and fluctuations were wider than recom-

mended. December flows were higher than requested, as the power generation demand increased. Meeting the below Bonneville natural spawning habitat protection needs will require modified management of Grand Coulee, Libby and Hungry Horse and NTS management primarily.

- Relaxation of flood control requirements at major reservoirs and redistribution of evacuation of flood control volumes from late March to early April might enhance flow conditions at the beginning of migration.
- Spring flow augmentation at Dworshak resulted in delaying the refill of the reservoir until July 15, and 123 KAF less water was available for the summer migration.
- Due to favorable weather conditions, high precipitation, and delayed snowmelt, the summer flow target was met without drafting the reservoirs to BiOp required elevations. A total of 1530.6 KAF of augmentation water from Upper Columbia reservoirs remained in reservoirs on August 31. Although summer migrants would have benefited from higher flows, the Opinion summer flow targets were managed as a cap on flows. The Salmon Managers requested prudent reservoir management actions in September 1999 through January 2000 period in order to meet flow requirements for late fall chinook migration in September 1999 and chum spawning below Bonneville in October through January. Because of the priority of power generation the agencies request was not met. September 1999 flows for late fall chinook migration were not met as requested by Fishery Agencies. Instead reservoirs were managed for power generation and whitefish releases.
- The current use of Treaty and Non Treaty Storage does not maximize the potential for meeting BiOp targets for meeting spring and summer flows. The highest NTS releases were during the October through December period for power generation purposes. There is no upper limit for releases for trout spawning below Arrow, which could allow NTS releases during critical periods of low flows in the April through May period. Instead, BPA was storing water in May, when flows were lower than BiOp requested minimum flows at McNary.

II. 1999 Spill Management

A. Spill

1. Overview

In March of 1995, an ESA Section 7 Biological Opinion (Opinion) on the operation of the Federal Columbia River Power System was issued. The Opinion established a set of reasonable and prudent alternatives (RPA) with the objective of improving the operation and configuration of the federal power system to meet a no jeopardy requirement of the Endangered Species act (ESA), and to fulfill the United States commitment to uphold tribal treaty fishing rights. One of the RPA established a Biological Opinion spill program for fish passage.

In May of 1998, the NMFS issued a Supplemental Biological Opinion (Supplemental Opinion) to the Biological Opinion signed on March 2, 1995. The Supplemental Biological Opinion was developed in part to address the needs of the newly listed as threatened Snake River steelhead and the Lower Columbia River steelhead, as well as the endangered Upper Columbia River steelhead. The Supplemental Biological Opinion calls for additional spill to the gas caps on a system-wide basis to provide further benefits to steelhead, while also increasing the survival of Snake River spring/summer and fall chinook and sockeye. To the extent that the fish passage efficiency (FPE) at some projects will exceed 80%, this additional spill supplements 1995 RPA Measure 2 for an interim period pending decisions regarding biologically based performance standards for project passage.

The Supplemental Opinion also modified the planning dates for the initiation and duration of the spill program. The planning dates start spill earlier in both the Snake and lower Columbia rivers, with the actual initiation of the spill program dependent on the presence of juvenile migrants based on in-season fish monitoring information.

The purpose of the spill program is to improve the downstream passage of ESA listed stocks by providing a route with less associated mortality than turbine passage. It is recognized that spilling water generates atmospheric gas supersaturation of the river that can have detrimental effects on fish. In providing spill as an alternate passage route the associated mortality due to dissolved gas supersaturation needs to be balanced against mortality of turbine passage.

2. Spill Planning

The 1999 water year was characterized at the April 1 forecast to be 123% of average run-off volume above Lower Granite Dam, and 121% of average above The Dalles Dam for the January to July time period. By comparison, the runoff volume was 98% of average above The Dalles Dam and 105% of average above Lower Granite Dam for the same period during 1998. The cold weather during the spring resulted in delaying the snowmelt until later in the season. Consequently, flows during the 1999 spring migration season were considerably less than those observed during other years with similar volume runoffs. The average monthly flows that occurred at Lower Granite and McNary Dams are contained in Table 20.

TABLE 20. Average monthly flows at Lower Granite and McNary dams in 1999.

Month	Average Monthly Flow (kcfs)	
	Lower Granite	McNary
April	93.9	245.7
May	112.5	282.2
June	133.7	330.9
July	54.8	247.9
August	37.7	208.5

3. Total Dissolved Gas Waivers

In 1999, as in previous years, the NMFS requested that the Oregon Department of Environmental Quality (DEQ), the Washington Department of Ecology (DOE), the Idaho Department of Health and Welfare and the Nez Perce Tribe, consider a waiver of the water quality standard for total dissolved gas supersaturation (TDGS). Because of the risk associated with dissolved gas supersaturation, the requested waiver was for a twelve-hour average of 115 and 120 percent TDGS in the forebay and tailrace of a project, respectively. The waivers were granted for the 1999 season by the state water quality agencies, but not by the Nez Perce Tribe.

The Oregon DEQ granted a waiver request from the USFWS for the March 18-28 spill period associated with the Spring Creek Hatchery fall chinook release, as did Washington Department of Ecology. Consequently, the provision of spill was allowed up to the 120% total dissolved gas criteria.

4. Spill Implementation

The water conditions during 1999 were above normal in terms of volume runoff. In general, however, because of the shape of the runoff, spill was managed to meet the TDGS waivers, with the exception of some time during the height of the spring runoff. Therefore, spill during the spring passage season could be manipulated such that total dissolved gas levels were generally at, or below, the waivers during most of the migration season.

Snake and Clearwater Rivers

Flow levels at Dworshak and the Hells Canyon Complex projects often exceeded hydraulic capacity during March and early April. Spill occurred as Brownlee and Dworshak were drawn down to reach flood control levels during March. Spill began early in April and for the most part ended on June 20 at Lower Granite, Little Goose and Lower Monumental dams, while continuing through August at Ice Harbor Dam.

Dworshak

Spill (Figure 7) occurred at this project throughout most of March in order to achieve a specific flood control elevation. During March inflows increased and this snowmelt was passed through the project, rather than retained, in order to remain at flood control elevation resulting in flows in excess of powerhouse capacity. This operation affected the ability to have sufficient water for flow augmentation later in the season, as Dworshak did not refill by June 30.

Some spill occurred in April, but at levels that did not exceed the 110% waiver, because of the fact that the Nez Perce had not allowed for a total dissolved gas waiver. Spill occurred again during flow augmentation for the summer period. Spill was limited by the 110% TDGS level during most of the summer except during the period from July 31 to August 8 when levels of 120% were acceptable to the Environmental Protection Agency for flow augmentation purposes.

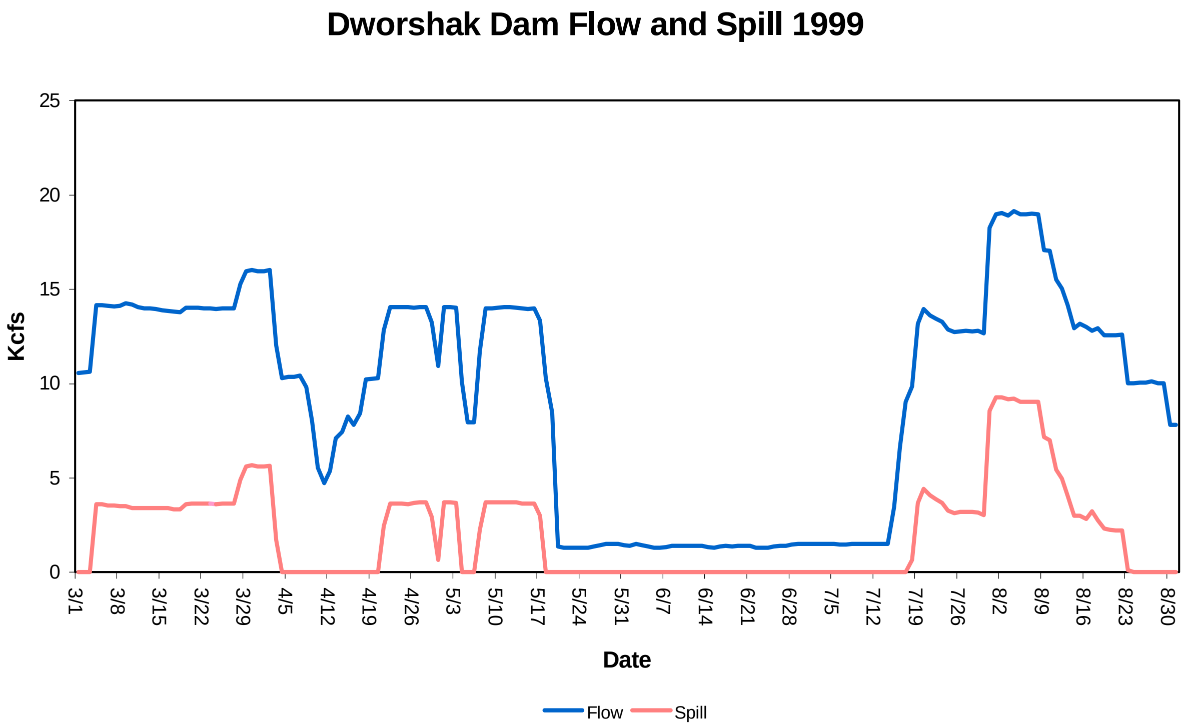


FIGURE 7. Project flow and spill at Dworshak Dam, 1999.

Lower Granite Dam

A request was made by the fishery agencies to initiate spill on March 31, 1999 based on increasing numbers of juvenile migrants passing Lower Granite Dam. That request was modified by the BPA to begin on April 2, 1999 based on pre-scheduled power commitments. In the 1998 Supplemental Biological Opinion NMFS set a spill equal to the gas cap at a level of 45 Kcfs for 12 hours (1800 to 0600 hours). Unlike past years spill at the project was not limited for surface bypass collector studies. Consequently, unlike past years, the 80% FPE was achieved, or nearly achieved, far more often during the fish migration period (Figure 8). There is no spill requirement for summer spill at this project, as transportation is maximized for subyearling migrants.

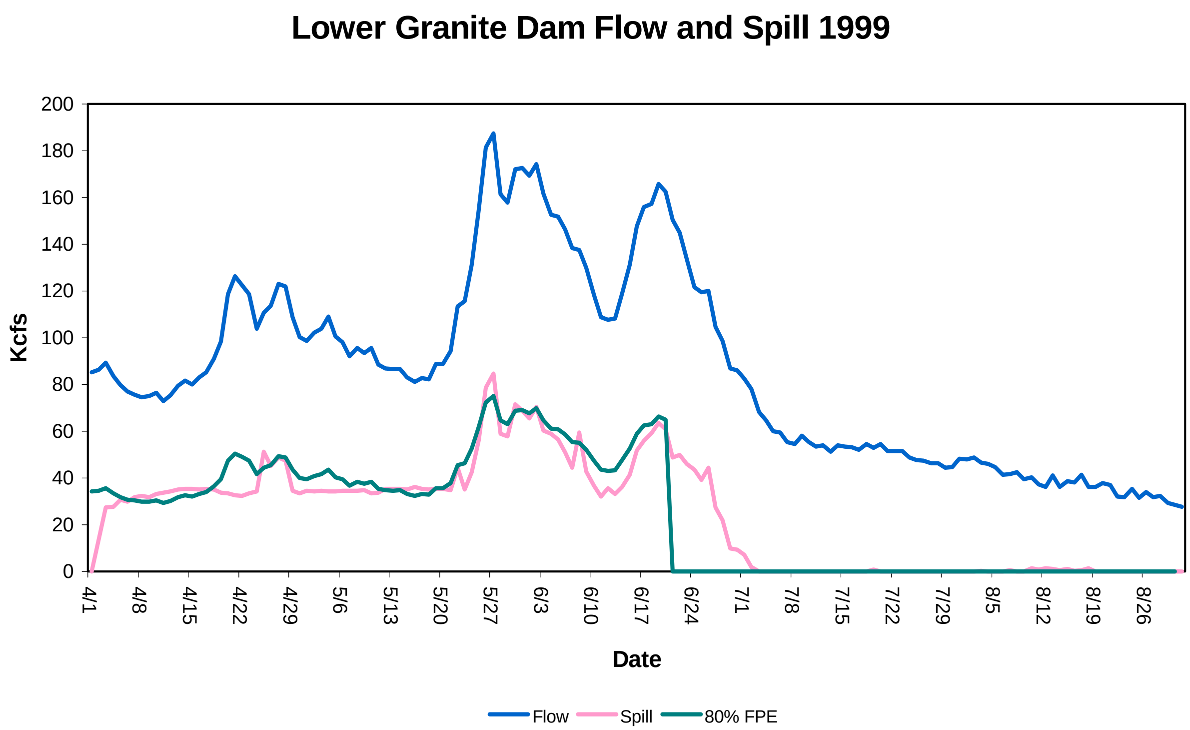


FIGURE 8. 1999 Lower Granite Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

Little Goose Dam

The 1998 Supplemental Biological Opinion sets spill at this project to 60 Kcfs for a 12-hour period. Spill began on April 2, 1999 according to the modified implementation of spill presented by BPA. At this project the 80% FPE was only met early in April (Figure 9), and again during late May. There is no Biological Opinion spill requirement for this project during the summer.

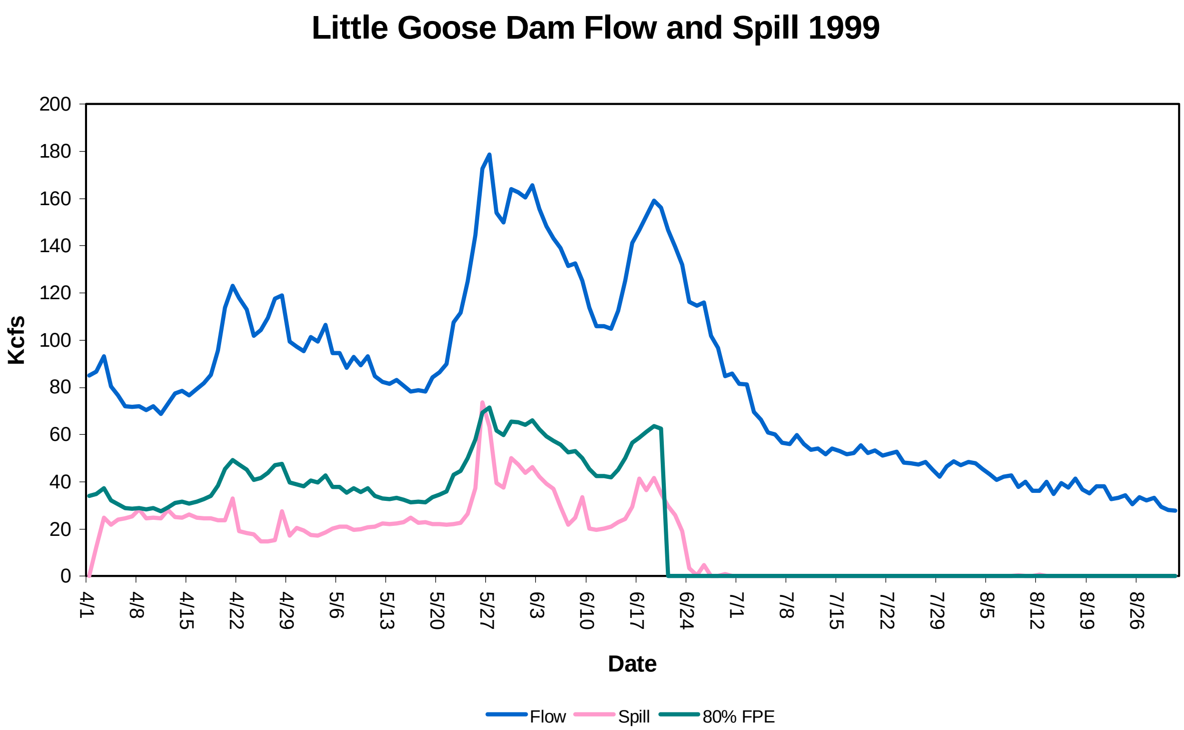


FIGURE 9. 1999 Little Goose Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

Lower Monumental Dam

At this project spill levels were set to 40 Kcfs for a 12-hour period. This recommendation in the Supplemental Opinion presented no change from previous conditions. Spill began on April 2, 1999 according to the modified implementation of spill presented by BPA. At this project the 80% FPE was not met (Figure 10). As with the other Snake River transportation sites, there is no requirement for summer spill according to the Biological Opinion.

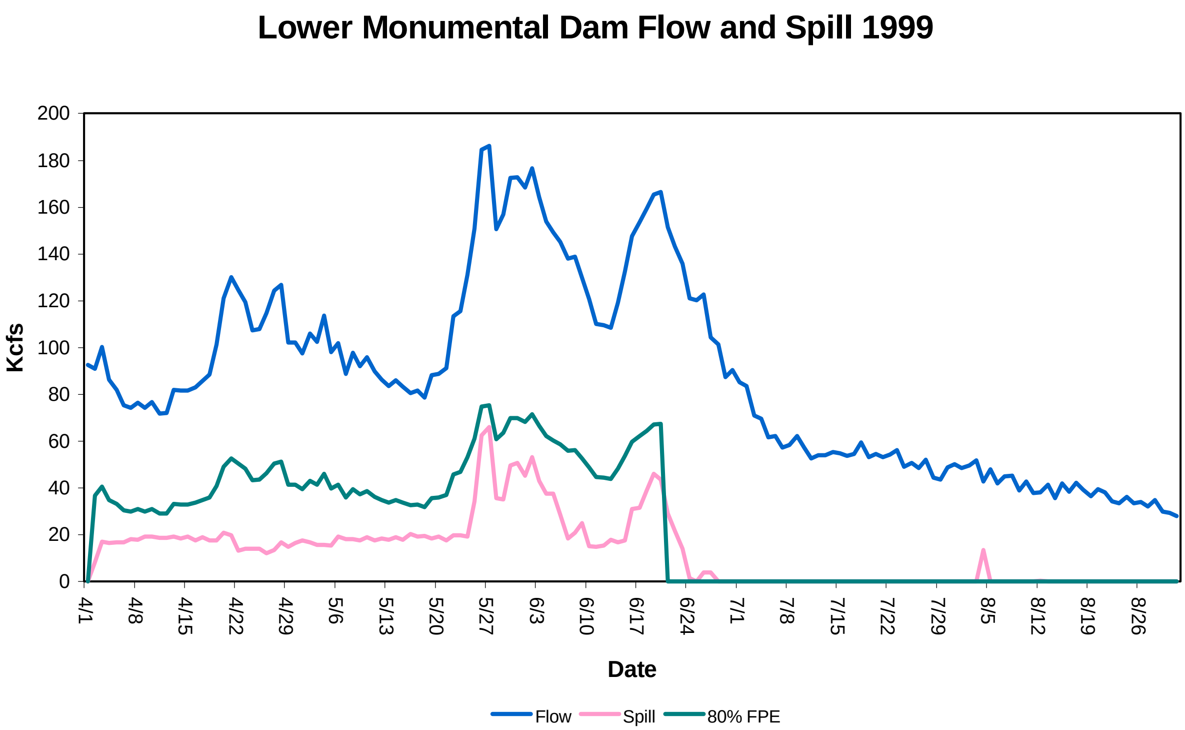


FIGURE 10. 1999 Lower Monumental Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

Ice Harbor Dam

The Supplemental Opinion specifies an instantaneous spill level of 75 Kcfs. Spill began on April 3, 1999 according to the modified implementation of spill presented by BPA. The 80% FPE was exceeded through most of the spring migration because of uncontrolled spill and nearly met during the summer migration. (Figure 11).

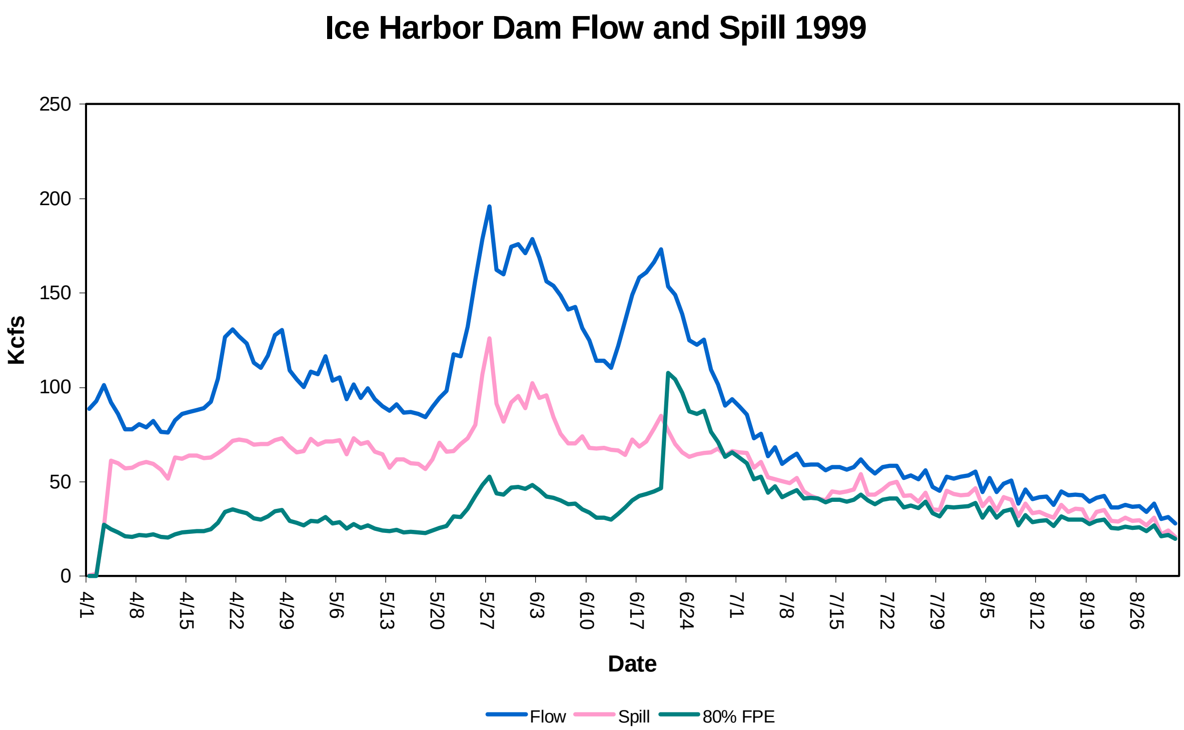


FIGURE 11. 1999 Ice Harbor Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

Lower Columbia River

The 1997 water year was above normal in the lower Columbia River. Peak flow exceeded 350 Kcfs during the early part of June. Spill was a product of excess hydraulic capacity and over-generation spill. The fishery agencies and tribes submitted a System Operational Request for spill to begin earlier than the planning date in the Lower River. However, due to system conditions BPA could not implement the SOR and proposed alternatives for implementing spill. While the agencies and tribes continued to support the implementation of the dates and volumes specified in the SOR, they recognized the system constraint and accepted an alternative proposal put forth by BPA. Sill continued through the spring and summer in the lower Columbia.

McNary Dam

Spill for fish passage was initiated on April 11 at 1800 hours at 50 kcfs for 24 hours daily. Biological Opinion spill began on April 20. Spill occurred at this project throughout both the spring and summer migration mostly due to a limitation on the hydraulic capacity of this project (Figure 12). The Supplemental Opinion specifies that spill will occur at an instantaneous rate of 150 Kcfs. During the spring migration the project exceeded the 80% FPE for 100% of the time. There is no summer spill requirement in order to maximize transportation, but because of the high flows spill continued throughout most of the summer.

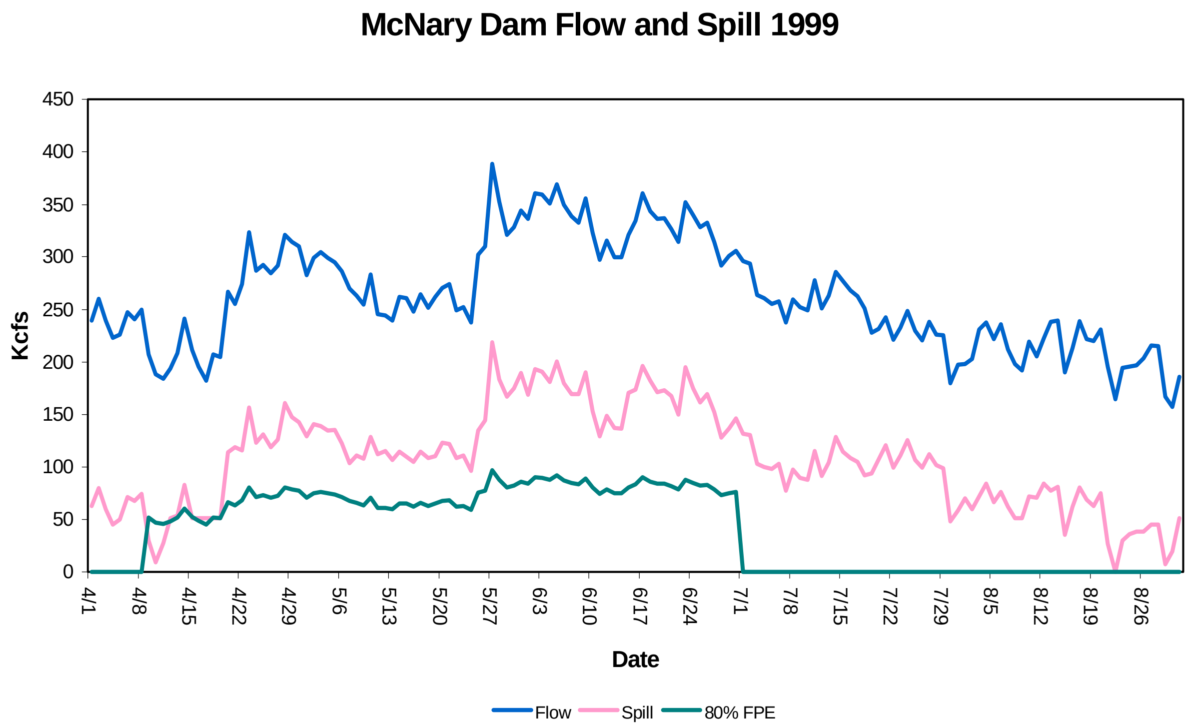


FIGURE 12. 1999 McNary Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

John Day Dam

The installation of spill flow deflectors has resulted in a substantial increase in the amount of spill that can occur at this project without exceeding the gas waiver. The Supplemental Opinion specifies a level of 180 Kcfs. While the 1995 Biological Opinion specified spill for 12 hours, the action agencies decreased the number of hours of spill required in order to decrease the cost of spill at this project. Spill began at this project on April 12, 1999 as 35% of instantaneous flows for 12 nighttime hours. Biological Opinion spill was implemented beginning April 20. Higher runoff during the spring resulted in spill that exceeded the 80% FPE on some days during May.

Because of dissolved gas limitations spill almost never achieved the 80% FPE (Figure 13). In fact far less spill produced higher gas levels than were experienced in 1998. There is some evidence that the higher tailwater levels at John Day in 1999 were the source of this discrepancy as the project was being operated outside the design performance criteria for the spillway deflectors. Some tests are planned for the winter of 1999-2000 to determine the gas levels at different tailwater elevations.

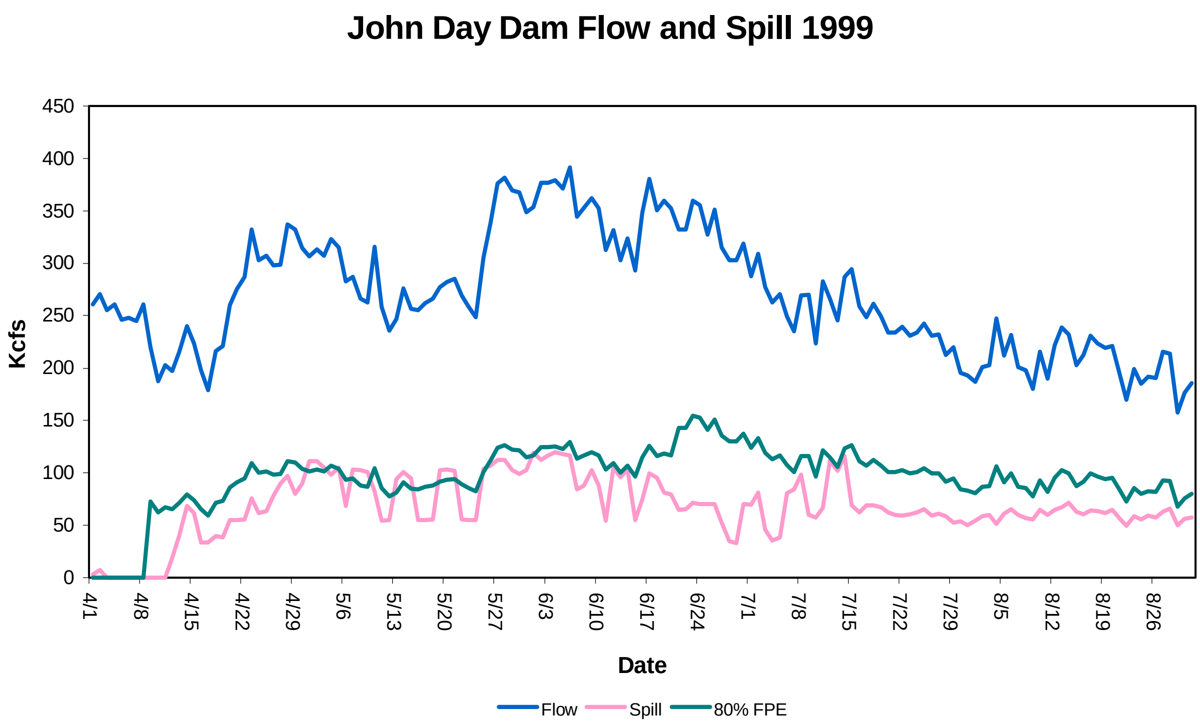


FIGURE 13. 1999 John Day Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

The Dalles Dam

Spill at The Dalles Dam in 1998 was dictated by the requirements of The Dalles spill test conditions. Spill alternated between 30% of total flow conditions and 64% of total flow conditions. As seen in the graph (Figure 14) spill came close to the 80% FPE on the 64% spill test days. The tests ended in late July and after this period the project achieved the 80% FPE level.

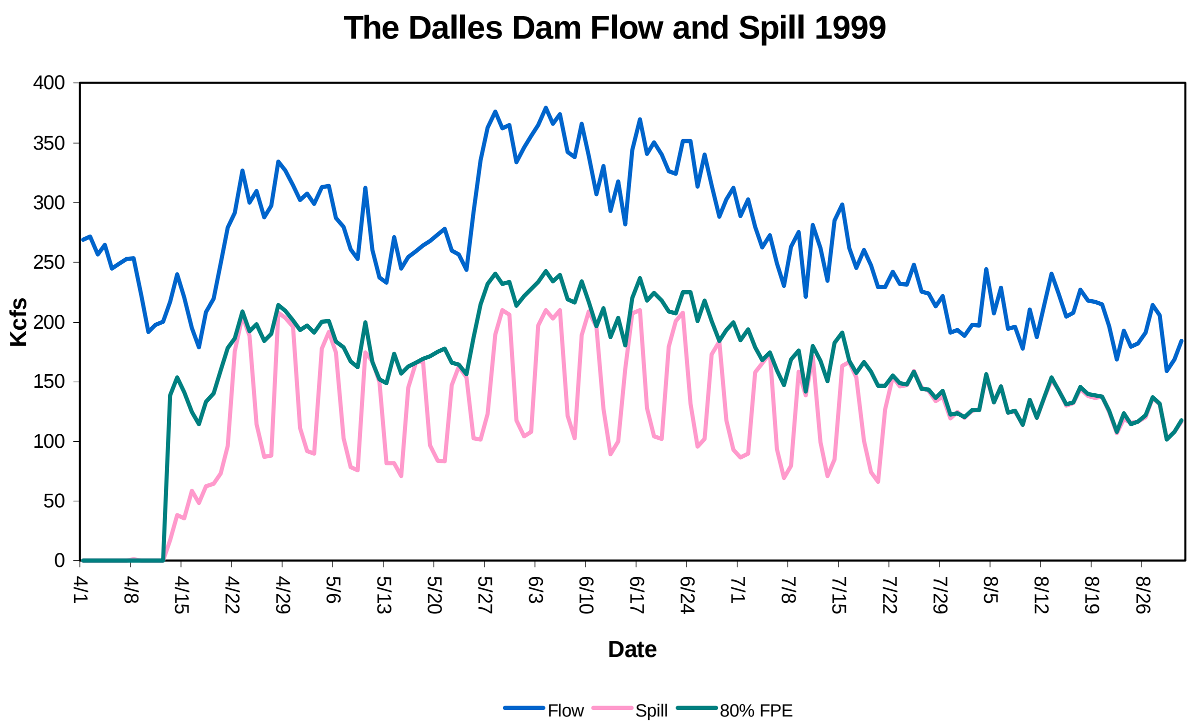


FIGURE 14. 1999 The Dalles Dam flow and spill compared to that identified in the 1995 Biological Opinion as necessary to achieve the 80% fish passage efficiency standards.

Bonneville Dam

The Supplemental Opinion made no changes to the levels of spill specified for Bonneville Dam in the 1995 Biological Opinion. At Bonneville Dam the spill is limited to prevent adult fall-back. Spill is not to exceed 75 Kcfs during daytime hours and can be up 100% of flow, limited to the gas cap, during nighttime hours. Under these conditions the 80% FPE is not achievable. During the 1999 migration season the 80% FPE was not achieved (Figure 15).

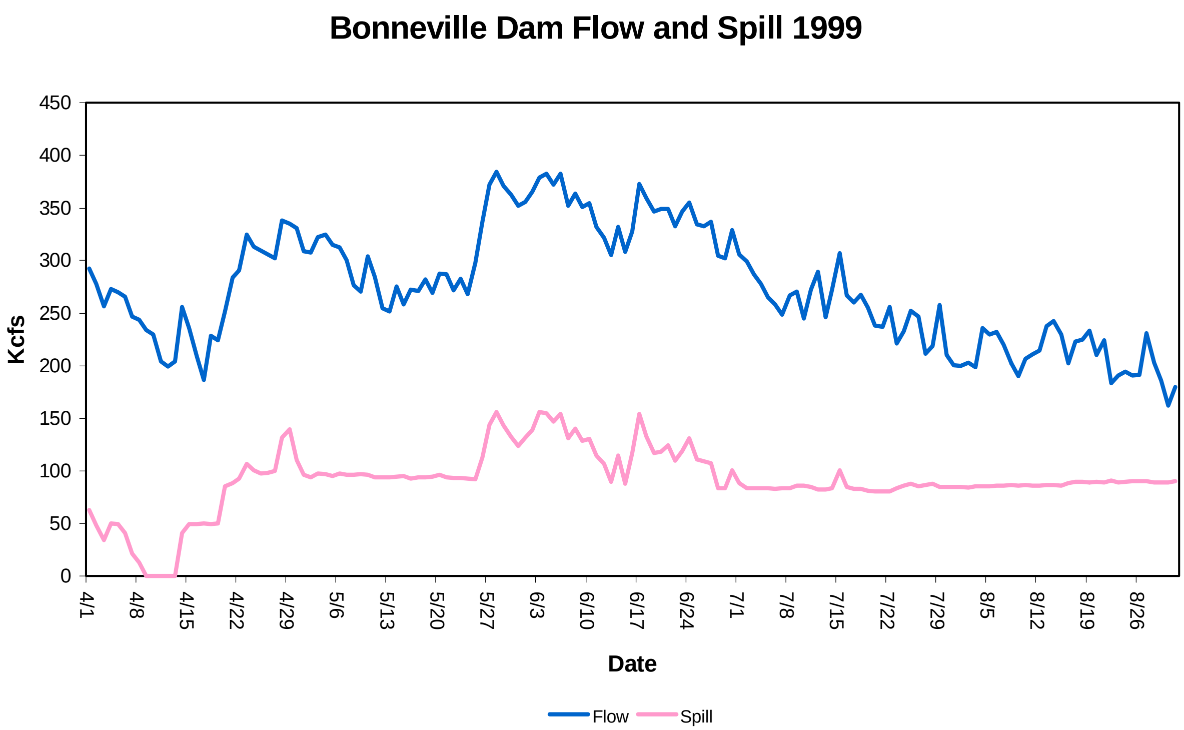


FIGURE 15. 1999 Bonneville Dam flow and spill and the estimated FPE achieved.

B. Voluntary and Involuntary Spill

In any given year, the federal operators and regulators are directed to spill according to the Biological Opinion. Dependent on the water year a certain amount of Opinion spill is involuntary spill. In 1999, the BPA and the COE collected data to allow for the distinction of voluntary and involuntary spill.

As can be seen the graph (Figure 16), spill during 1999 was in large part involuntary. In other words, spill in excess of hydraulic capacity or generation capacity comprised a significant amount of the spill in the spring. In the Snake River, over 60% of the spill that occurred during the spring period was involuntary. Ice Harbor Dam is the only Lower Snake project that has a summer spill program. As summer progressed and flows decreased, an increasing proportion of the spill could be deemed voluntary. Only this volume of spill can be legitimately considered fish spill as called for by the Biological Opinion. In the lower Columbia, mostly all spill at McNary dam was involuntary due to the river flows and the limited hydraulic capacity of this project. At

John Day Dam, most all spring spill and a great proportion of the summer spill was voluntary. At The Dalles and Bonneville dams, involuntary spill decreased as the season progressed. It is important to recognize that whenever voluntary spill occurred in the system the projects where spill occurred complied with the State waivers for TDGS. Exceedences of the criteria occurred during periods of involuntary spill, which were not as great as observed in past years due to the shape of the runoff.

The data collected in 1999, an above average water year, again illustrate that the violations of the established criteria for the total dissolved gas criteria that occurred were due to flows in excess of turbine capacity and available power market. The most significant gains made towards decreasing the levels of TDGS were made at Ice Harbor and John Day dams with the installation of gas abatement structures. The majority of the spill that occurred during the migration period was not specifically provided for fish, but was primarily involuntary.

In the Snake River, a small amount of spring spill and some summer spill was voluntary and can be considered fish spill as called for by the Biological Opinion. In the lower Columbia, all spill at McNary Dam was involuntary. At John Day and Bonneville dams, 80 to 90% of spill was involuntary, while at The Dalles Dam almost 70% was involuntary. However, it is important to note that whenever voluntary spill occurred in the system the projects where spill occurred complied with the State waivers for TDGS. Exceedences of the criteria occurred during periods of involuntary spill.

Figure 16 summarizes the total amount of spill at each project from April through August. The graph again illustrates that given the 1998-water year; very little spill can actually be called voluntary.

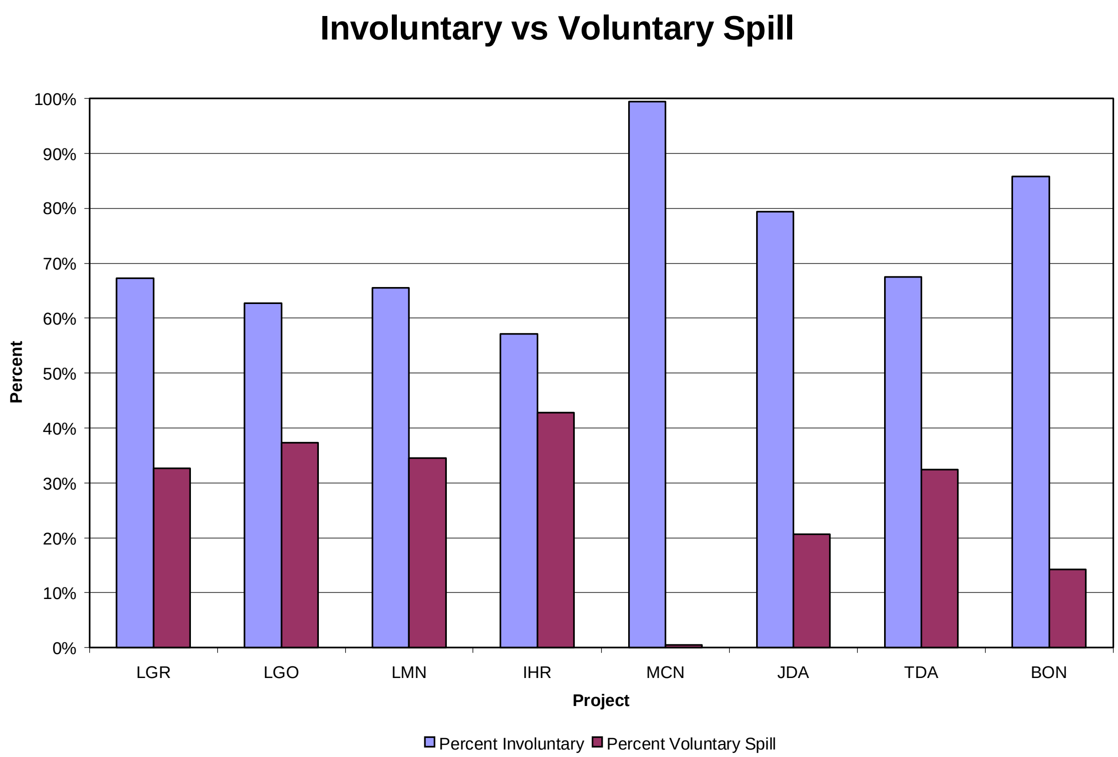


FIGURE 16. Comparison of involuntary and voluntary spill at lower Snake and Columbia dams.

C. Summary and Conclusions

- The provision of spill for fish released from the Spring Creek Hatchery continued to be contentious because they are hatchery fish released outside of the Biological Opinion spill program. Spill was allowed for these fish up to the 120% TDGS levels with approval from the States' of Oregon and Washington.
- Spill during the season was primarily involuntary and resulted from flows in excess of hydraulic capacity and power needs.
- Due to uncontrolled spill the total dissolved gas levels during the late spring were in excess of the 115/120% water quality waiver provided by the state water quality agencies, but because of the shape of the runoff due to the delaying of the snowmelt, this exceedence occurred for a much shorter duration than in past years.

- The installation of spillway deflectors at Ice Harbor and John Day dams resulted in lower levels of TDGS below these projects during 1999. However, much less water was spilled at this project than in 1998 because the TDGS level was reached at a lower level of spill. This situation will be investigated further.
- Summer spill was managed for provision of the Biological Opinion spill for fish passage, within the constraints of the State waivers for TDGS.

D. Gas Bubble Trauma Monitoring and Data Reporting

1. Overview

Monitoring of juvenile salmonids in 1999 for GBT was conducted at Bonneville Dam and McNary Dam on the Lower-Columbia River, and at Rock Island Dam on the Mid-Columbia River. The Snake River monitoring sites were Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam. Sampling of fish began the first full week of April at all sites and continued through mid June at the Snake River sites, when the numbers of steelhead and yearling chinook were too few to sample effectively. Subyearling chinook were not sampled in the Lower Snake River due to their endangered status and because the Biological Opinion does not call for the implementation of summer spill at the Snake River collector projects. Sampling of subyearling chinook did occur at Columbia River sites, where spill continued to the end of August.

Sampling occurred two days per week at the Lower Columbia sites and once a week at Lower Granite, Little Goose and Lower Monumental in the Snake River. Sampling at Ice Harbor Dam was conducted twice a week in conjunction with the smolt sampling at the facility. In previous years fish were sampled every other day (3 to 4 days per week) at most facilities. The number of sampling days was reduced in 1999, in order to decrease the number of fish handled. It was determined that the reduced sampling effort would not significantly diminish the capability to detect the presence of GBT in the migrating population. Further, if high TDGS levels were encountered, the number of sampling days per week would have been increased. However, total dissolved gas saturation (TDGS) levels only exceeded the NMFS waiver levels of 115% in forebays and 120% in tailraces for a short period of time during the spring spill season, and sampling frequency was never increased as a result.

The goal was to sample 100 fish of each of the dominant species during each day of sampling at each site. Examinations of fish were done using a variable magnification (6x to 40x) dissecting scope. The lateral line, both eyes, and unpaired fins were examined for the presence of bubbles. The bubbles present in the fins were quantified using a ranking system based on the percent area of the fins covered with bubbles. A rank of 0 was recorded when no bubbles were present; rank 1 was recorded when up to 5% of a fin area was covered with bubbles; rank 2 was for 6% to 25%; rank 3 indicated 26% to 50% fin area was bubbled; and rank 4 indicated greater than 50% of a fin was covered with bubbles. The left side lateral line was examined for the presence of bubbles. A similar ranking system to that used for the fins was used to assign a rank to the percent lateral line occluded. Based on the average number of lateral line scales in chinook and steelhead, the length spanned by 7 lateral line scales was equivalent to approximately 5% of the total length of the lateral line. The scale approximation was used as a guide to estimate percent occlusion. Then a rank was assigned based upon this approximation. It was assumed that few fish would have greater than 5% lateral line occlusion. The eyes of the fish were also examined and the eye with the highest amount of bubbles in it was ranked using the same criteria as was used for the fins. Additional information was recorded for each fish including, species, age, race, rearing disposition, fork length, fin clips, and tags. The examination procedures were similar to those used in past years of the program.

Sampling techniques varied somewhat based on the location. This year all sampling sites were at dams, where fish could be collected from the juvenile fish bypass system. At those dams where fish crossed separators the fish were collected as they entered the separator. At Bonneville Dam fish were collected from the bypass trap that was sampled every 30 minutes from 4 pm to midnight. Rock Island Dam is the only site where fish were held in a tank (up to 24 hours) prior to examination.

2. Results

A total of 25,184 juvenile salmonids were examined for GBT between April and August (Table 21). A total of 419 or 1.7% showed some signs of GBT in fins, eyes or lateral lines (Table 22). Fin signs were found in 148 or 0.6% of the fish sampled at all sites. The fin signs, by

TABLE 21. Number of juvenile salmonids examined for signs of GBT at dams on the Lower Snake River and on the Columbia River from April to August 1999 as part of the GBT Monitoring Program.

	Site							
Species	BON	MCN	IHR	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	2,165	2,500	0	0	0	0	1,876	6,541
Chinook Yearlings	1,733	1,800	1,449	884	993	897	1,607	9,363
Steelhead	1,859	1,053	1,090	1,110	1,105	1,100	1,963	9,280
Total	5,757	5,353	2,539	1,994	2,098	1,997	5,446	25,184

highest rank in each fish with signs, were as follows: 118, or 0.5%**,** were rank 1; 29 or 0.1% were rank 2; and 1 fish or 0.0% was rank 3 or greater. The prevalence of GBT signs at Rock Island Dam was higher than any other Columbia River site during the 1999 monitoring season. Because the Rock Island data may obscure other inter-annual trends in the occurrence of GBT signs among sites, it will be treated separately in the remainder of this report.

TABLE 22. Number of juvenile salmonids found with any signs of GBT at dams on the Lower Snake River and on the Columbia River from April to August 1999 as part of the GBT Monitoring Program

Species	Site							
	BON	MCN	IHR	LMN	LGS	LGR	RIS	Total
Chinook Subyearlings	3	14	0	0	0	0	48	65
Chinook Yearlings	8	51	38	14	8	13	57	188
Steelhead	6	40	46	36	2	10	25	165
Total	17	105	84	50	10	23	130	419

The percent of fish with signs of GBT was relatively low in 1999, similar to 1998 when these years were compared to 1997 and 1996. At Lower Columbia River and Snake River sites (i.e. excluding Rock Island) a total of 19,738 fish were examined with 289 (1.4%) exhibiting signs of GBT, compared to 1.6% in 1998, 4.3% in 1997, 4.2% in 1996 and 1.3% in 1995.

A total of 63 (0.3%) fish from the Lower Snake and Lower Columbia rivers showed fin signs. The fin signs found in 1999 were a considerable reduction in prevalence compared to 1.0% in 1998, 3.2% in 1997 and 3.3% in 1996. The incidence of severe fin GBT was also very low in 1999 when only 1 fish (0.001%) showed severe signs, which was similar to 1998 when only 4 (0.01%) fish displayed severe fin signs. But 1999 incidence was much lower than 1997 when 117 fish (0.27%) had severe fin signs (again excluding Rock Island) and 47 fish (0.12%) in 1996. There were no incidences of severe GBT in 1995.

The Biological Opinion Spill Program was managed using the data collected for total dissolved gas levels. However, signs of GBT in fins of juvenile fish, examined as part of the biological monitoring, were used to compliment the physical monitoring program. The NMFS set the action criteria for the biological monitoring program at 15% prevalence of fish having fin signs **or** 5% with severe signs (rank 3 or greater) in fins. **The NMFS action criteria were never exceeded**

in 1999 (based on dates when at least 30 fish of the species exhibiting signs were sampled). When Rock Island Dam is removed from the calculations, there were no exceedences of the NMFS action criteria in 1999 or 1998, but 25 dates when GBT levels surpassed the action criteria in 1997, 20 in 1996, and there were no exceedences in 1995.

The prevalence and severity of fin signs in juvenile salmonids sampled in the Lower Snake and Lower Columbia rivers from 1995 to 1999 reflected changes in TDGS conditions in the river from year to year. In 1995 no fish had severe fin GBT and 1995 had the lowest number of days with high TDGS (Table 23). Also the occurrence of severe signs in 1996 and 1997, and the increase in exceedences of the NMFS action criteria, reflected a significant increase in the number of days when TDGS rose above 125% in the forebays of these dams (see Table 23 and Table 24). While in 1998 only 4 fish were found with severe fin GBT and 1 fish in 1999, reflecting the more moderate conditions found in the river.

TABLE 23. The number of days when TDSG levels were above 120% and 125% at representative forebay monitors in the Lower Snake and Lower Columbia Rivers from April 1 to August 31.

	1999		1998		1997		1996		1995	
COE TDGS Monitor	Days >120	Days >125	Days >120	Days >125	Days >120	Days >125	Days >120	Days >125	Days >120	Days >125
Lower Granite	0	0	0	0	0	0	0	0	0	0
Little Goose	5	0	8	3	23	8	29	6	0	0
Lower Monumental	7	2	14	8	61	31	64	33	0	0
Ice Harbor	5	1	14	4	52	19	41	11	0	0
McNary (Oregon	3	0	0	0	46	0	30	4	3	0
John Day	0	0	7	0	47	15	33	11	0	0
Bonneville	0	0	3	0	65	27	45	6	0	0
Total	20	3	46	16	294	100	242	60	3	0

TABLE 24. The number of days when NMFS GBT criteria of 15% prevalence or 5% severe signs were exceeded at sites in the Lower Snake and Lower Columbia rivers from April 1 to August 31.[ab]

Site	1999	1998	1997	1996	1995
Lower Granite	0	0	0	0	0
Little Goose	0	0	1	1	0
Lower Monumental	0	0	7	9	0
Ice Harbor	0	0	3	2	0
McNary	0	0	2	1	0
John Day	0	0	1	4	0
Bonneville	0	0	11	4	0
Total	0	0	25	21	0

[a] Based on dates when at least 30 fish of the species exhibiting signs were captured.

[b] More than 5% of fish showed severe signs on only 1 date in each year 1996 & 1997 and on those same dates the prevalence of fin signs was greater than 15%.

E. Total Dissolved Gas Saturation

The 1999 TDGS levels were much lower system-wide than in other recent years. Colder than normal temperatures in April, and early May resulted in a very gradual snow-melt which translated into lower flows and less spill than initially forecast by COE. As a result TDGS levels were relatively low, with values above the waiver limits for only a short two-week period in mid-May when projects spilled excess powerhouse capacity volume.

Dworshak

Total dissolved gas levels never went above the 120% this migration season. Although there was some excess capacity spill in April it did not result in TDGS levels above 110% (the federal water quality standard). By May 4 spill ended and TDGS levels remained below 115% until mid-July. Fisheries agencies requested a waiver to 120% TDGS for flow augmentation from July 30 to August 15. The EPA allowed the waiver through August 8 but then required spill be gradually reduced to meet the 110% standard by August 15. Thus TDGS values were above 115% for only one week during the entire season when outflow was 19 kcfs and spill was approximately 8 kcfs during summer flow augmentation.

Lower Granite Dam

Forebay readings at this project are typically low because of its location. Values measured at the forebay monitor never exceeded 111% during the entire season. Tailwater TDGS levels rose to 120% TDGS in early April as average hourly nighttime spill of 55 to 65 kcfs for BiOp began. The TDGS level fluctuated between 110% and 120% until May 26 when daily average spill in excess of hydraulic capacity of 85 kcfs was measured. This was the peak spill level for 1999 and TDGS levels rose to 130% on that date but quickly receded below 120% by June 4. Saturation values rose above 120% again from June 17 to 20 as spill again occurred in excess of hydraulic capacity reaching daily average of 61 kcfs on June 19. By July 3 spill ended and TDGS levels fell below 105% as the powerhouse passed incoming saturation.

Little Goose Dam

Total dissolved gas saturation remained near or below 115% (i.e. within 2%) through much of the spring spill season, when hourly nighttime spill at Lower Granite was 55 to 65 kcfs. During the peak spring flows in late May, as spill in excess of hydraulic capacity was occurring at Lower Granite, forebay TDGS at Little Goose rose above the 115% waiver on May 22 and remained above that level until June 24. Spill for fish at Little Goose began on April 2 at nearly 50 kcfs (nighttime hourly average) but was reduced to below 30 kcfs on April 22 as the higher initial spill volumes produced gas levels above 115% at Lower Monumental forebay. The tailwater TDGS at Little Goose did not exceed 120% at any time prior to April 22, and when spill was reduced on that date the tailwater TDGS levels fell to 116%. As lower spill levels were maintained at the project, TDGS levels at Little Goose tailwater fell to 114% on April 26. Saturation values remained well below the waiver limit until May 25 when the peak spring flows occurred. Maximum daily average spill occurred on May 25 at 71 kcfs. Peak TDGS level of 127% occurred on May 26. Tailwater TDGS values were above the 120% waiver limit for only 4 days during the season, all of these were measured when spill was occurring in excess of hydraulic capacity.

Lower Monumental Dam

Forebay gas levels were in excess of the water quality waiver limit (115%) shortly after spill for fish management began in early April, causing spill at Little Goose to be reduced from nighttime average hourly value of 50 kcfs to 30 kcfs on April 22. Based on a comparison of the Little Goose tailwater TDGS to Lower Monumental forebay, it appeared that little or no dissipation of gas was occurring between dams. For example, when the tailwater TDGS at Little Goose was reading 116% (average of 12 highest hours) on April 22 to 24 then dropped to 115% on the April 25, the forebay at Lower Monumental went from 115% to 117% from April 23 to April 25. Oddly, TDGS values at the tailwater monitor at Lower Monumental were sometimes measuring lower values than in the forebay. For example, on April 17 the average of 12 highest hourly readings in the forebay was 121% while the tailwater monitor measured 118% for the 12 highest hourly readings on the same date. The TDGS readings remained below 120% in the tailwater at Lower Monumental Dam until the peak flows occurred the last week of May. The peak flows resulted in maximum TDGS levels of 131% measured on May 27.

Ice Harbor Dam

Spill for fish began April 3 at Ice Harbor. Total dissolved gas measurements in the tailwater remained below 115% despite peak hourly average spill of nearly 81 kcfs. The COE questioned these data and in late April ran transects to determine the representativeness of the fixed monitoring site data. The COE found readings at the monitor 2 to 4% below nearest transect measurements. They identified a problem with the standpipe in which the monitor was housed. The sensor was significantly higher in the standpipe than water circulation holes. The COE eventually fixed the problem on May 3. After the standpipe was modified, TDGS levels measured 119% on May 5 when nighttime hourly average spill was near 105 kcfs. Peak TDGS levels were measured May 27 at 130%, when spill of 125 kcfs was occurring and total flows were (195 kcfs) in excess of hydraulic capacity.

McNary Dam

Total dissolved gas levels of 115% were being measured in the tailrace when spill began April 11 at the request of the fisheries managers. The spill was limited to daily average of 70 to 80 kcfs. On April 20 when BiOp spill of 120-160 kcfs was implemented, TDGS levels measured in the tailwater rose to the 120% waiver limit. TDGS levels remained at or above the waiver limit from May 24 to June 30 as spill occurred in excess of hydraulic capacity.

John Day Dam

The BiOp calls for daily average spill to be 35% of flow during night hours at this project during spill season. However, the tailwater monitor measured TDGS levels at 124% (avg. 12 highest hours) on June 17 and as a result the COE reduced daily average spill to 20 to 25% of river flow (60 to 65 kcfs). Fisheries managers suspected the spillway deflectors were being operated outside their design criteria. The low spill levels of 60 kcfs allowed by the TDGS waiver limit were similar to levels allowed prior to the addition of deflectors at the project. The COE ran test spills and eventually determined that lowering tailwater elevation allowed higher spill volumes. But spill was reduced to pre-deflector levels until July 6, when 32% of total flow was spilled. A further complication was a post-season analysis of the monitoring program, showing that the tailwater monitor probably was malfunctioning during this time period. However, because of improper calibration (i.e. the calibrated standard may have been reading erroneously), it is hard to determine exactly how far off the tailwater monitor had been. Data provided by USGS, who discovered the monitor's gas coefficients were not programmed properly, suggests that readings for June 29 to July 7, were probably low by as much as 2 percent. **In any case, NMFS** estimated that thousands of fish were killed due to the reduction in spill that occurred because of overestimation of TDGS readings at the downstream monitor. It was this controversy, and the perception that the COE reacted slowly to the problem, that prompted the request to develop more formal notification and emergency response procedures for the 2000 season.

The Dalles Dam

Total dissolved gas measurements remained at or below the 120% standard in the tailwater of this project for the entire season. Tailwater TDGS levels remained relatively stable at 120% throughout the season, despite alternating spill regimes in which spill was 70 to 105 kcfs (30% of total discharge) for 3 days then 170 to 210 kcfs (64% of total discharge) for 3 days.

Bonneville Dam

Total dissolved gas measurements remained at or near waiver limits (115%) throughout the season at Bonneville forebay. Tailwater measurements at Warrendale and Skamania also stayed at or below the tailwater waiver limit (120%) for the entire season with only a few dates having reached 121%.

Rock Island Dam

Forebay TDGS readings were highly erratic until April 28 when values leveled off near 110%.

Spill of 40kcfs, 24 hours a day, commenced on April 20 at Rock Island according to FERC guidelines. Consequently TDGS rose in the tailwater to 118% on April 21; up from 107% on April 18. The TDGS levels remained near 118% when spill was maintained at 40 kcfs.

F. Dissolved Gas and Gas Bubble Trauma Summary and Conclusions

There appears to be a good correlation between the levels of TDGS and the prevalence of signs of GBT found in the biological monitoring program. A comparison among dams and years when TDGS levels were above 120% in the forebays of various dams, may be useful in characterizing the general conditions in which the juvenile fish migrated. Based on that comparison it is apparent that in 1999 TDGS levels were higher than in 1995 but did not approach the high levels nor the duration experienced in 1996 and 1997. In ranking the years in terms of high gas levels 1997 had the highest, 1996 was second, followed by 1998, 1999 and finally 1995 with the lowest levels of TDGS.

A similar ranking of years in terms of a comparison of severe GBT signs (in fins) and number of days the NMFS criteria were exceeded results in the same ranking: 1997 showed the greatest number of exceedences, followed by 1996, while none were found in 1995, 1998, nor 1999. For the record, the number of fish exhibiting severe fin GBT was higher in 1999 (1 fish) than in 1995 when no fish had severe fin signs. The comparison of incidence of severe signs to high TDGS shows that high incidences GBT only occur during periods when the gas levels are well above the water quality waiver. Indeed in 1999, as in 1998 and 1995, there were no dates when the NMFS biological criteria were exceeded when samples sizes were greater than 30 fish per target species. The low incidence of signs in the biological monitoring in 1999, 1998, and 1995 reflect the relatively low gas saturation levels seen those years.

While research related to characterizing GBT signs in relation to exposure to high TDGS have found often contradictory and confusing results when trying to relate the progression of signs to level of exposure, the GBT monitoring program has shown that the incidence of signs in migrating juvenile salmonids follows the levels of TDGS in the river quite closely. Laboratory experiments at USGS-BRD in Cook, Washington found high incidences (60% to 80%) of fin GBT in fish exposed to relatively low gas levels for long periods (110% TDG for 22 d). The levels of fin signs found in the "chronic exposure scenario" was indistinguishable from levels of signs found in fish exposed to "acute" high levels (130% TDG for 4 h to 8 h). By comparison the biological monitoring program found the incidence of fin signs rarely approached 10% when TDGS levels at dam forebays were below 115%. Indeed, only at Rock Island Dam did the incidence of fin GBT ever approach the levels of incidence found in the laboratory. At that site there are some serious questions about the effects of collection and holding of the fish that may influence the relative incidence of signs. At all other sites the incidence of GBT never exceeded 40% when the sample sizes were large enough to have reasonable confidence that the incidence sampled at the dam was representative of the migrating population (i.e. near the 100 fish target sample size). At TDGS levels of 120% or higher the incidence of fin signs in laboratory experiments exceeded 80%, while the biological monitoring found percent fin signs only approached 10% to 15% when TDGS levels in the forebays of the dams reached 125%. The laboratory exposures are indeed as the researchers describe them "a worst case scenario".

While the difference between laboratory results and monitoring results has led some to conclude that fish were dying or that signs were disappearing before the fish could be examined for GBT, researchers sampling fish in reservoir, have found the levels of signs in the reservoir are similar to those in the biological monitoring program. According to research by NMFS, the monitoring program found a higher incidence of signs than those in fish captured by the researchers sampling fish in the forebay of the same dam. Other research by NMFS has shown that the incidence of signs in the fish passing through the bypass prior to examination for GBT does not change significantly. Therefore, we conclude that GBT monitoring does accurately depict the incidence of signs in fish passing the dams and may in some cases slightly over estimate the incidence. However, over-estimation of the incidence of signs would only serve to protect the population since NMFS action criteria are set so that steps are taken when the incidence exceeds 15%. Thus slight overestimation would prove protective of the migrating fish. Realistically, the times the NMFS criteria have been exceeded occurred during periods of uncontrolled spill and TDGS levels have been well above the 120% tailwater and 115% forebay limits set by water quality agencies. At such times little can be done to reduce TDGS levels.

Based on the results of the monitoring it appears that fish behavior combined with short duration of exposure in tailwater due to high water velocity may diminish the effective exposure of the fish. Indeed the very moderate levels of signs found in the biological monitoring data suggest that the intermittent exposure fish experience greatly reduces the incidence of signs relative to those observed in laboratory conditions. Because the migrating population does not manifest nearly the level of signs that are seen in long term exposures in the laboratory it seems reasonable to conclude that exposure is both less severe and more importantly much less lethal than laboratory experiments suggest. Further, because the correlation between TDGS levels and incidence of signs is more consistent in monitoring data than in laboratory experiments its more likely that if mortality due to exposure to high TDGS were quantifiable its rate would vary with the incidence of signs found in the monitoring program.

III. 1999 SMOLT MONITORING

A. Smolt Monitoring Sites and 1999 Schedules.

Information on the status of the Columbia Basin salmonid smolt migration is collected each year to aid the Fishery Agencies and Tribes in making management decisions beneficial to smolt survival as they migrate from natal streams through the hydro system to the ocean. The Smolt Monitoring Program collects data on relative fish abundance at dams, fish migration timing at traps and dams, fish travel time between monitoring sites, and fish survival from traps and dams to downstream monitoring sites. Some of this data is generated for each species from the run-at-large and some of this data is generated from specially marked groups of fish. All of this data is collected for the purpose of in-season management of flows and spills and the post-season evaluation of the effect of that year's management actions on migrating salmonids.

This information is obtained from eleven monitoring sites in the Columbia River basin (sites and dates of operation are presented in Table 25). These monitoring sites include four traps in tributaries above Lower Granite Dam, three dams on the lower Snake River, one dam in the mid-Columbia River reach, and three dams on the lower Columbia River. During periods of monitoring, the daily collection information from each of these sites is transmitted to the Fish Passage Center, where it is stored and compiled into data summaries for distribution to interested parties in the region. This data is posted daily on the Fish Passage Center's web page at www.fpc.org.

Appendix F Table F-1 lists the days when non-standard samples or no samples were obtained during the monitoring period due to conditions such as high flow and debris levels, equipment failures, scheduled dewatering for maintenance, transportation changes, and fish disease concerns. On those days a biased or "null" collection count will occur.

This chapter and associated appendices present data from the 1999 Smolt Monitoring Program on the (1) collection counts at each monitoring site (plus relative magnitude [termed passage index] at dams), (2) migration timing at key sites, (3) travel time between selected sites, and (4) estimates of survival between selected sites. Greater details of the sampling at the traps and dams may be found in the individual reports prepared by the respective monitoring organizations. Washington Department of Fish and Wildlife (WDFW) reports on sampling at Lower Granite, Lower Monumental, Rock Island, and McNary dams. Oregon Department of Fish and Wildlife (ODFW) reports on sampling at Little Goose Dam and the Grande Ronde River trap. Idaho Department of Fish and Game (IDFG) reports on sampling at the traps on the Salmon and Snake rivers. Nez Perce Tribe (NPT) reports on the sampling at the Imnaha River trap. Pacific States Marine Fisheries Commission (PSMFC) reports on the sampling at John Day and Bonneville dams.

TABLE 25. Smolt monitoring sites and schedules for 1999.

Site	Sampling method	Dates of Operation	Primary fish data
Salmon River trap (km103)	Scoop trap	17:30 3/14 – 09:00 5/21	Counts; fish quality*; PIT tag releases
Imnaha River trap (km6.8)	Screw trap(s) (1-2 traps)	08:35 3/1 – 07:55 6/24	Counts; fish quality; PIT tag releases
Grande Ronde River trap (km 5)	Scoop trap	18:15 3/14 – 09:00 6/3	Counts; fish quality; PIT tag releases
Snake River trap (km 225)	Dipper trap	13:00 3/14 – 21:00 5/24**	Counts; fish quality; PIT tag releases
Snake River dams: Lower Granite Dam (km 173)	Timed subsample from bypass	07:00 3/25 – 07:00 11/10	Counts; fish quality; gas bubble signs (1 day per week [d/w])
Little Goose Dam (km 113)	Timed subsample from bypass	07:00 4/1 – 07:00 11/4	Counts; fish quality; gas bubble signs (1 d/w)
Lower Monumental Dam (km 67)	Timed subsample from bypass	07:00 4/1 – 07:00 10/31	Counts; fish quality; gas bubble signs (1 d/w)
Columbia River dams: Rock Island Dam (km 730)	Census of fish in volitional bypass at Powerhouse 2	09:00 3/31 – 09:00 8/31	Counts; fish quality; PIT tag releases; gas bubble signs (2 d/w)
McNary Dam (km 470)	Timed subsample from bypass	12:45 3/29 – 07:00 12/15	Counts; fish quality; gas bubble signs (2 d/w)
John Day Dam (km 347)	Timed subsample from bypass	20:00 4/7*** – 24:00 10/26	Counts; fish quality
Bonneville Dam**** (km 234)	Powerhouse 1: bypass trap	16:00 3/13 – 24:00 10/29	Counts; fish quality; gas bubble signs (2 d/w)

* fish quality includes descaling and injury data.

** the last sample for season ended in calendar day preceding the normal end-date.

*** initial sampling occurred 20:00 April 1 to 12:00 April 2 prior to equipment malfunction; sampling was resumed five days later after repairs completed.

**** no sampling at Bonneville Dam Powerhouse 2 other than monitoring of PIT tags.

B. Collection Counts and Relative Abundance.

In the March through October weekly reports prepared by the Fish Passage Center, a daily passage index is presented for each species and rearing type available in the run-at-large. As long as these daily passage indices remain highly correlated with daily population abundance existing at a given monitoring site, the fishery managers may use the daily passage indices to effectively determine significant shifts in passage at that monitoring site. The actual value of fish guidance efficiency of the screens or effectiveness of spill is not required, only the existence of seasonal stability of these factors is required. The daily passage indices account for daily changes in spill proportion under the conservative assumption that the proportion of fish passing through spill will be close to the proportion of water being spilled. For these reasons, when the Smolt Monitoring Program began in 1984, the use of daily passage indices was chosen over attempts to estimate daily absolute population sizes. The daily passage index is computed by dividing the daily collection by the proportion of water passing through the powerhouse where the sampling takes place (Table 26). Since 1998, sampling at John Day Dam has been with a timed sample from the entire powerhouse bypass system instead of only one gatewell slot as occurred in prior years. At monitoring sites where a sample timer is used to systematically divert a fixed proportion of fish into a sample tank for processing, the resulting sample number is divided by the sample rate to arrive at the estimated collection number. Post-season the daily passage indices are summed for the season at a given site to provide an annual passage index for each species and rearing type available. This annual passage index reflects the strength of the particular run for the given year. The passage index is not applicable to the trap sites; therefore, only collection counts are reported at the four traps.

TABLE 26. Formulas to compute passage indices (collection/flow expansion factor) at dams.

Sampling Site	Years	Collection	Flow expansion factor
Rock Island Dam (PH 2)	1985-99	Catch / 1	PH2/(PH1+PH2+SP)
Lower Granite Dam Little Goose Dam Lower Monumental Dam McNary Dam	1984-99 1984-99 1993-99 1984-99	Catch / sample rate	PH/(PH+SP)
John Day Dam (bypass) John Day Dam Unit 3	1998-99 1984-97	Catch / sample rate Catch / 1	PH/(PH+SP) Unit3/(PH+SP)
Bonneville Dam (PH 1)	1986-92 1993-95 1996-99	8 hr catch / sample rate 24 hr catch / sample rate 8 hr catch / sample rate	PH1/(PH1+PH2+SP)

Legend: PH=powerhouse flow; PH1=first powerhouse flow; PH2=second powerhouse flow; SP=spill flow; and Unit3=turbine unit 3 flow (note: all flows are daily average values).

Table 27 presents the cumulative counts of salmonids at the four traps above Lower Granite Dam over the scheduled dates of operation in 1999. These traps operated primarily on a 5 days per week schedule (Sunday afternoon through Friday morning). Sampling on the Imnaha River involved the use of two traps during much of the season to increase the number of fish for PIT tagging purposes. These counts simply reflect how many fish were handled at these traps for timing, fish condition, and PIT tagging purposes. We do not have measures of trap efficiencies for any expansion to run size.

TABLE 27. **1999 Sampled numbers of wild (W) and hatchery (H) chinook, steelhead, and sockeye at the four traps used in the Smolt Monitoring Program**

Species	No. of Fish Sampled	Species	No. of Fish Sampled
Salmon River Trap (aboveWhitebird)		**Snake River Trap (at Lewiston)**	
W Chinook 1's	5,079	W Chinook 1's	6,411
H Chinook 1's	23,180	H Chinook 1's	15,326
W Steelhead	228	W Steelhead	1,050
H Steelhead	2,554	H Steelhead	7,271
W Sockeye	0	All Sockeye	175
H Sockeye	41	All Coho	130
		W Chinook 0's	62
Imnaha River Trap		**Grande Ronde River Trap**	
W Chinook 1's	5,706	W Chinook 1's	1,623
H Chinook 1's	12,853	H Chinook 1's	4,197
W Steelhead	2,753	W Steelhead	1,696
H Steelhead	8,852	H Steelhead	5,752

The 1999 cumulative number of fish sampled at each dam, along with expanded collection and passage index levels for the season, are presented in Table 28 for Snake River dams, along with a comparison to the 1998 annual passage indices. At Little Goose and Lower Monumental dams the 1999 passage indices of yearling chinook, steelhead, coho, and subyearling chinook were higher than in 1998. At these two dams the passage index of total sockeye was similar but the relative split between hatchery and wild fish changed greatly between years. However, when we look at Lower Granite Dam, the passage indices of steelhead, coho, and hatchery sockeye were much lower in 1999, and the passage index of yearling chinook, though higher than in 1998, was not higher by the level seen at the downstream two dams. More fish passed Lower Granite Dam without collection in 1999 compared to 1998 based on what was being observed at the next two dams downstream. Levels of spill and the configuration of the surface collector/behavioral curtain must have jointly resulted in a higher percentage of fish passing through spill at the dam than occurred last year. Subyearling chinook passage indices were higher in 1999 due to the release of 300,000 hatchery subyearling fall chinook from Big Canyon Creek acclimation pond in the Clearwater River drainage and Captain Johns Rapids acclimation pond in the mainstem Snake River below the confluence with the Grande Ronde River.

TABLE 28. Sample, collection, and passage indices of Salmonids at Snake River dams in 1999 with passage indices compared to 1998.

Dam	Species	Rear Type	1999 Sample	1999 Collected	1999 Passage Index	1998 Passage Index
Lower Granite	Chinook Age 0	All	50,965	257,507	311,150	89,122
	Chinook Age 1	Wild	8,688	410,842	636,634	374,547
	Chinook Age 1	Hatchery	16,782	1,762,654	2,768,104	1,723,579
	Coho	All	1,621	78,621	126,763	216,911
	Steelhead	Wild	4,611	323,083	502,347	754,976
	Steelhead	Hatchery	36,030	3,032,104	4,732,401	6,163,490
	Sockeye	Wild	489	7,975	11,958	1,382
	Sockeye	Hatchery	420	10,085	16,230	66,284
Little Goose	Chinook Age 0	All	32,664	197,964	212,382	53,733
	Chinook Age 1	Wild	10,559	703,534	907,185	241,713
	Chinook Age 1	Hatchery	21,651	2,828,828	3,681,203	994,083
	Coho	All	1,561	117,421	158,700	78,289
	Steelhead	Wild	3,469	325,774	425,367	241,527
	Steelhead	Hatchery	26,615	2,809,841	3,691,246	1,891,769
	Sockeye	Wild	254	11,935	15,650	797
	Sockeye	Hatchery	148	9,124	12,373	25,496
Lower Monumental	Chinook Age 0	All	22,960	133,285	137,079	24,692
	Chinook Age 1	Wild	13,024	338,080	420,688	88,345
	Chinook Age 1	Hatchery	66,844	1,554,363	1,952,854	555,621
	Coho	All	1,084	51,163	68,199	45,431
	Steelhead	Wild	4,993	196,132	250,734	171,766
	Steelhead	Hatchery	58,009	1,782,663	2,289,251	1,119,902
	Sockeye	Wild	306	7,736	9,793	1,162
	Sockeye	Hatchery	139	5,136	6,738	21,196

The 1999 cumulative number of fish sampled at each dam, along with expanded collection and passage index levels for the season, are presented in Table 29 for Columbia River dams, along with a comparison to the 1998 annual passage indices. The 1999 annual passage indices for chinook (yearlings and subyearlings), steelhead, coho, and sockeye at Rock Island Dam were all higher than in 1998. The largest increases at Rock Island Dam were for hatchery steelhead (100% higher), yearling and subyearling chinook (60% higher), and wild steelhead (50% higher) than last year. These increases put the 1999 hatchery steelhead passage index on par with the 1997 level, while the 1999 yearling chinook passage index is still below the 1997 level. The 1999 annual passage indices at McNary Dam were higher than 1998 levels by 112% for yearling chinook, 88% for hatchery steelhead, and 54% for wild sockeye. As for wild steelhead and coho at McNary Dam, the increase in 1999 annual passage indices were more moderate at 16-22%, while for hatchery sockeye and subyearling chinook a drop of 23% and 33%, respectively was observed compared to last year.

By the time fish are passing John Day Dam, many of the 1999 annual passage indices are very similar to last year (Table 29). Differences of 10% or less was observed for coho, wild steelhead, and wild and hatchery sockeye at John Day Dam in 1999 compared to 1998, while hatchery

TABLE 29. Sample, collection, and passage indices of Salmonids at Snake River dams in 1999 with passage indices compared to 1998.

Dam	Species	Rear Type	1999			1998
			Sample	Collected	Passage Index	Passage Index
Rock Island	Chinook Age 0	All	18,641	18,641	28,340	17,204
	Chinook Age 1	All	25,609	25,609	40,284	24,996
	Coho	All	28,876	28,876	46,180	41,815
	Steelhead	Wild	5,885	5,885	9,259	6,168
	Steelhead	Hatchery	19,321	19,321	30,366	15,329
	Sockeye	Wild	13,015	13,015	20,490	15,061
	Sockeye	Hatchery	1,665	1,665	2,631	1,650
McNary	Chinook Age 0	All	189,859	4,276,091	7,637,199	11,278,053
	Chinook Age 1	All	35,874	2,104,612	3,692,922	1,739,906
	Coho	All	2,230	140,758	281,939	241,423
	Steelhead	Wild	1,482	78,031	144,845	118,250
	Steelhead	Hatchery	8,800	459,767	859,528	458,067
	Sockeye	Wild	8,454	763,487	1,408,460	913,896
	Sockeye	Hatchery	325	19,647	37,898	49,128
John Day*	Chinook Age 0	All	231,130	3,090,151	3,963,160	2,153,497
	Chinook Age 1	All	160,188	1,590,919	2,186,669	1,148,682
	Coho	All	37,937	388,818	543,151	572,774
	Steelhead	Wild	33,480	295,982	415,312	455,858
	Steelhead	Hatchery	41,549	575,034	808,195	634,705
	Sockeye	Wild	53,236	391,416	551,371	500,116
	Sockeye	Hatchery	1,474	15,982	22,481	23,750
Bonneville Power House #1	Chinook Age 0	All	35,637	474,874	1,692,673	1,591,883
	Chinook Age 1	All	15,279	165,918	638,607	346,281
	Coho	All	8,411	98,370	375,644	513,643
	Steelhead	Wild	2,549	28,834	108,165	159,916
	Steelhead	Hatchery	5,647	65,488	243,144	237,299
	Sockeye	Wild	2,008	31,706	112,802	102,960
	Sockeye	Hatchery	110	1,394	5,405	11,604

*John Day Dam shows 1999 cumulative beginning April 7. Excludes data from April 1-2 (16 hrs) due incomplete sampling with periods of unknown sample rate due to equipment malfunctions.

steelhead was moderately higher by 27% in 1999. The largest increases in passage indices at John Day Dam occurred for yearling and subyearling chinook in 1999, with levels 91% and 84%, respectively, higher than last year. Both McNary and John Day dams saw increases from 1998 to 1999 in their yearling chinook annual passage index. The increase at both sites was due to fish originating above McNary Dam since hatchery production in the Umatilla River of yearling spring and fall chinook was similar both years, and no transportation of springtime migrants occurred from McNary Dam in both years. The increasing trend between years in subyearling chinook annual passage indices at John Day Dam was not expected given the decreasing trend at McNary Dam and a 1999 hatchery production in the Umatilla River of subyearling fall chinook that was approximately 35% lower than the previous year. The higher June flows in 1999 compared to 1998 may have passed more subyearling chinook through McNary Dam's spillway routes than were accounted for by the 1999 annual subyearling chinook passage at McNary Dam.

The increasing trend in magnitude from 1998 to 1999 annual passage indices for yearling chinook as observed at McNary and John Day dams continues at Bonneville Dam, with an increase of 84% (Table 29). Likewise, the trend of similarity between years for wild sockeye as observed at John Day Dam continues at Bonneville Dam (very few hatchery sockeye were seen at Bonneville Dam). The trend between years for other species differed at Bonneville Dam from John Day Dam. Coho and wild steelhead annual passage indices for 1999 at Bonneville Dam were lower than in 1998, but similar between years at John Day Dam. Hatchery steelhead annual passage indices for 1999 were similar to 1998 levels at Bonneville Dam, but higher in 1999 than 1998 at John Day Dam. Annual passage indices for subyearling chinook at Bonneville Dam were fairly similar between 1998 and 1999, rather than higher in 1999 as observed at John Day Dam. Passage indices of subyearling chinook at Bonneville Dam are highly influenced by localized Bonneville pool hatchery production ("upriver bright" fall chinook releases [over 6 million annually] from Klickitat and Little White Salmon River hatcheries and "tule" fall chinook releases [10.6 million in 1999 and 16.0 million in 1998] from Spring Creek Hatchery).

In most situations, distinguishing between hatchery and wild fish is done based on whether or not the adipose fish has been clipped. In the Snake River basin, hatchery yearling chinook, hatchery steelhead, and hatchery sockeye are generally adipose clipped to designate hatchery origin. However, in 1999 the Snake River basin's natural supplementation program used a blank wire tag inserted in the fishes' snout as the only method to distinguish these fish. Therefore, a CWT detector was used at the traps on the Salmon and Snake rivers and at Lower Granite, Little Goose, and Lower Monumental dams to detect these fish and count them as the hatchery fish instead of as wild fish. Table 30 shows the collection number of supplementation fish detected at the five sites using the CWT detectors. Since not all hatchery yearling chinook passing the lower Columbia River monitoring sites are adipose clipped anyway, there was no reason to use a CWT detector to look for the natural supplementation fish at McNary, John Day, or

TABLE 30. Number of natural supplementation (NS) yearling chinook collected at the traps on the Salmon and Snake Rivers and at Snake River dams.[a]

Site	NS fish detected	Total hatchery	NS fish % of total hatchery	Total wild	Wild bias% if NS fish included[a]
Salmon River trap	494	23,180	2.0 %	5,079	9.7 %
Snake River trap	502	15,326	3.3 %	6,411	7.8 %
Lower Granite Dam	70,138	1,762,654	4.0 %	410,842	17.1 %
Little Goose Dam	138,302	2,828,828	4.9 %	703,534	19.7 %
Lower Monumental	55,980	1,554,363	3.6 %	338,080	16.6 %

a. =bias in wild chinook collection number if these natural supplementation fish had been counted as wild instead of counted as hatchery based on detection of blank wire tag.

Bonneville dams. Although the percentage of natural supplementation fish did not exceed 5% of the total number of hatchery fish collected at the traps and dams, the failure to separate these fish from the wild yearling chinook would have biased the wild yearling chinook collection at the dams upwards of nearly 20%.

To distinguish the hatchery yearling fall chinook released from Lyons Ferry Hatchery both on-site and out-planted into the three acclimation ponds above Lower Granite Dam, a colored elastomer (plastic) tag was inserted into the fleshy tissue above an eye. At the traps and dams where these fish may be present, the crews checked all hatchery chinook for the presence or absence of an elastomer tag, and all fish with an elastomer were entered into the mark recapture database. This mark recapture data has been expanded from sample to collection to passage index and is shown in Table 31.

TABLE 31. Cumulative 1999 passage index at traps and dams for the Snake River basin yearling fall chinook groups.[a]

Site	Captain John Rapids AP	Big Canyon Creek AP	Pittsburg Landing AP	Lyons Ferry Hatchery
Release Number	157,010	228,451	142,885	432,166
Snake R trap (coll.)	115	1	114	
Lower Granite Dam	65,228	75,623	63,062	
Little Goose Dam	46,879	74,780	52,663	176
Lower Monumental	22,933	40,948	18,956	156,133
McNary Dam	6,385	15,568	9,315	96,361
John Day Dam	3,379	4,345	3,161	36,954
Bonneville Dam	468	1,526	810	4,327

a. elastomer colors and positions were left eye blue color for Captain John Rapids acclimation pond (Snake River); left eye green color for Big Canyon Creek acclimation pond (Clearwater River); right eye green color for Pittsburg Landing acclimation pond (Snake River); and left eye red color for Lyons Ferry Hatchery on-site release (Snake River).

In Table 32, an estimate of the daily yearling spring/summer chinook passage indices at each dam is obtained by subtracting the daily yearling fall chinook passage indices from the daily total hatchery yearling chinook passage indices. The proportion of the cumulative passage indices of hatchery yearling chinook in the Snake River and total yearling chinook in the Columbia River that were hatchery yearling fall chinook from the Snake River basin ranged between 1 and 12.2% in 1999 depending on site.

TABLE 32. Cumulative 1999 passage indices for Snake River basin yearling hatchery fall chinook (distinguished by presence of colored elastomer tag) compared to overall yearling spring/summer chinook and total yearling chinook by rearing type.

Site	Rearing Type	Total Yearling Chinook	Hatchery Yearling Fall Chinook	Yearling Sp/Su Chinook	Yearling Fall Chinook %
Snake R trap (coll.)	Hatchery	15,326	230	15,096	1.5 %
Lower Granite Dam	Hatchery	2,766,986	203,913	2,563,073	7.4 %
Little Goose Dam	Hatchery	3,682,077	174,498	3,507,603	4.7 %
Lower Monumental	Hatchery	1,955,072	238,970	1,716,102	12.2 %
McNary Dam	All	3,692,953	127,629	3,565,324	3.5 %
John Day Dam	All	2,186,821	47,839	2,138,982	2.2 %
Bonneville Dam	All	638,607	7,131	631,476	1.1 %

All hatchery steelhead released from Chiwawa Hatchery in the Wenatchee River in 1999 were marked with colored elastomer tags. Three different colors were used to distinguish the parentage of the smolts being released: Wild x Wild crosses, Hatchery x Wild crosses, and Hatchery x Hatchery crosses. The cumulative passage indices for each elastomer group at the downstream dams are presented in Table 33.

TABLE 33. Cumulative 1999 passage indices for Chiwawa Hatchery elastomer tagged groups[a] at Columbia River dams.

Site	Hatchery x Wild	Wild x Wild	Hatchery x Hatchery
Release Number	37,132	82,684	53,051
Rock Island Dam	1,071	1,388	2,183
McNary Dam	4,195	3,973	7,643
John Day Dam	4,714	4,991	3,166
Bonneville Dam	292	502	563

a. colored elastomer position was left eye-green color for Hatchery x Wild crosses, orange color for Wild x Wild crosses, and red color for Hatchery x Hatchery crosses.

The only hatchery subyearling chinook within the Snake River drainage that were adipose clipped were the Lyons Ferry Hatchery fish released on-site. Therefore, at Lower Monumental Dam any subyearling chinook with an adipose clip was known to have originated at Lyons Ferry Hatchery. The total number of Lyons Ferry Hatchery subyearling chinook collected at Lower Monumental Dam was 70,253 fish, which equates to 52.7% of all subyearling chinook (hatchery and wild combined) collected at Lower Monumental Dam in 1999.

Subyearling chinook fry were collected at all dams but Lower Monumental Dam in 1999, plus eight fry were collected at the Imnaha River trap. Table 34 lists the number of subyearling chinook fry collected at the dams and the percentage of the total subyearling chinook collection this represents. All dams had less than 1.5% fry in the total subyearling chinook collection except at Rock Island Dam were it total 17.5% fry. The percent of fry collected at Rock Island Dam in April was 36% in 1999, half of the percentage collected in April of 1998, but closer to prior years. Of the remaining fry collected at Rock Island Dam, 42.5% occurred in June.

TABLE 34. Subyearling chinook fry collection numbers and percentages for 1999.

Site	Total subyearling chinook collected	Subyearling chinook fry collected	% fry in subyearling chinook collections
Lower Granite Dam	257,507	1,233	0.5 %
Little Goose Dam	197,964	205	0.1 %
Rock Island Dam	18,641	3,255	17.5 %
McNary Dam	4,276,091	60,373	1.4 %
John Day Dam	3,090,151	6,976	0.2 %
Bonneville Dam	474,874	1,967	0.4 %

Freeze brands were applied to groups of hatchery steelhead from the Lyons Ferry Hatchery complex that were released on-site from the hatchery, released in the Tucannon River, and volitionally released from Cottonwood acclimation pond on the Grande Ronde River. The crews at the sampling sites looked for freeze branded steelhead and when observed took a fork length. The hatchery is interested in the size distribution of their fish at the various downstream monitoring sites. In Table , the number of freeze branded fish observed in the samples and average fork length of the sampled fish is presented. On average, the fish from Cottonwood acclimation pond tended to be smaller than their cohorts released in the Tucannon River and on-site from Lyons Ferry Hatchery.

TABLE 35. Number (in parenthesis) and average length of freeze branded hatchery steelhead sampled at traps and dams in 1999.

	Cottonwood	Tucannon	Lyons Ferry Hatchery on-site releases			
	RA-IT-3	RA-IT-1	LA-IV-1	RA-IV-1	LA-IV-3	RA-IV-3
Grande Ronde R trap	212.4 (378)					
Snake River trap	209.3 (108)					
Lower Granite Dam	214.0 (184)					
Little Goose Dam	217.0 (140)					
Lower Monumental	220.0 (420)	246.0 (253)	239.1 (270)	236.0 (217)	239.1 (248)	235.5 (267)
McNary Dam	225.2 (23)	247.8 (33)	244.3 (20)	244.0 (5)	238.7 (16)	249.8 (18)
John Day Dam	217.2 (5)	243.2 (6)	250.1 (9)	243.5 (15)	239.8 (9)	254.3 (10)

C. Migration Timing.

The distribution of the daily passage indices at the dams provides a measure of migration timing at a given site. From the passage distributions at each dam, key cumulative percentiles of 10%, 50%, and 90% are reported for each species and rearing type available each year. This passage timing data is also plotted for the run-at-large as well as for PIT tagged groups. In 1999, fish were marked with either PIT (passive integrated transponder) tags implanted in the fishes' gut cavity, color elastomer (plastic) tags, or freeze brands. SMP crews look for the elastomer and freeze brands in the samples at the sites, while the PIT tags are generally electronically detected without the need for fish handling. Late in the season as the decommission of the 400 kHz PIT tag systems was underway in preparation for the new 132.6 kHz PIT tag systems for the Year 2000 outmigration season, some sites switched to hand detection of PIT tagged fish in the samples. Data from the color elastomer tags and freeze brands were presented in the previous section of this report. Data from PIT tags will be presented later in this section.

In the Snake River, the middle 80% passage period of springtime migrants in 1999 at Lower Granite Dam was similar at the start (date of 10% passage), but extended later than the historic median 90% passage dates for yearling chinook and steelhead, while ending earlier for coho (Table 36). The 1999 middle 80% passage timing of hatchery sockeye at Lower Granite Dam was within the historic range of combined hatchery and wild sockeye. Due the extremely large proportion of unclipped sockeye collected in late March and throughout April, it is apparent that fish designated as wild sockeye at Lower Granite Dam in Table 6 are mostly kokanee. The 1999 middle 80% passage period for subyearling chinook was shifted earlier than the historic period. However, the 1999 migration timing was heavily influenced by the large hatchery releases of unclipped subyearling chinook, which tend to migrate earlier than their wild counterparts.

In the Mid-Columbia River the start of the 1999 salmonid migrations past Rock Island Dam (Table 36) were relatively close to the historic median 10% passage dates, but the 90% passage date extended about two weeks later than the historic middle 80% passage period for subyearling chinook and wild and hatchery steelhead (and ten days longer for coho). By the time the mixture of Snake and Mid-Columbia River fish were passing McNary Dam, the migration timing in 1999 was fairly close to the historic middle 80% period for all salmonids except coho. The entire 1999 passage distribution of coho at McNary Dam was shifted about two weeks later than the historic middle 80% period. At John Day Dam we again see the later shift in the 1999 passage of wild and hatchery steelhead and coho compared to the historic middle 80% passage period. The subyearling chinook date of 90% passage at John Day Dam was about 20 days earlier than the historic median 90% passage date. The higher flows in the lower Columbia River in June and early July of 1999 may have moved more subyearling chinook by John Day Dam quicker than in the prior eight years used in generating the historic middle 80% passage period at that site.

The discussion of migration timing so far has been at the level of species and rearing type, but additional insight may be gathered by comparing the migration timing of fish originating from different tributaries and drainages. Figures 17 to 37 show the cumulative passage distributions of PIT tagged groups of yearling and subyearling chinook, steelhead, coho, and sockeye at key dams in the Columbia River basin. For fish first entering the hydrosystem in the Snake River drainage, Lower Granite Dam is the key site for comparison of migration timing of yearling chinook, steelhead, and subyearling chinook originating in the Clearwater, Salmon, Imnaha, Grande Ronde, or mainstem Snake rivers. The earliest hatchery yearling chinook to pass Lower Granite Dam in 1999 (median dates of passage before April 25) were the PIT tagged yearling fall chinook released from Pittsburg Landing and Captain Johns Rapids acclimation ponds in the Snake (Figure 17) and the yearling spring chinook released from Lookingglass Hatchery in the Grande Ronde River (Figure 18). The passage of the other PIT tagged hatchery yearling chinook at Lower Granite Dam (spring/summer chinook emigrating from the Salmon, Imnaha, and Clearwater rivers and fall chinook released from Big Canyon Creek acclimation pond in the Clearwater River drainage) were shifted a week or more later (median dates of passage after May 3).

TABLE 36. Migration timing of salmonids at Lower Granite, Rock Island, McNary, and John Day dams in 1999 compared to historic middle 80% passage period.[a]

Dam	Species	Rear Type	1999 10%	1999 50%	1999 90%	Historic[a] Middle 80% 10%	Historic[a] Middle 80% 90%
Lower Granite	Chinook Age 0	All (wild+ hatchery)	6/9	7/3	8/16	6/17[b] (Wild)	8/26[b] (Wild)
	Chinook Age 1	Wild	4/18	5/2	6/1	4/16[c]	5/20[c]
	Chinook Age 1	Hatchery	4/23	5/7	5/22	4/23[c]	5/16[c]
	Coho	All	5/20	5/27	6/7	5/18[d]	6/15[d]
	Steelhead	Wild	4/23	5/13	5/30	4/23	5/22
	Steelhead	Hatchery	4/24	5/8	5/27	4/28	5/22
	Sockeye and wild kokanee	Wild Hatchery	4/2 5/24	5/4 5/30	6/5 6/7	5/8 (All)	6/23 (All)
Rock Island	Chinook Age 0	All	6/10	7/15	8/14	6/6	7/31
	Chinook Age 1	All	4/24	5/7	5/28	4/26	6/04
	Coho	All	5/14	5/26	6/11	5/21[e]	6/1[e]
	Steelhead	Wild	4/27	5/25	6/16	4/30	6/3
	Steelhead	Hatchery	5/6	5/27	6/15	4/30	5/22
	Sockeye	Wild Hatchery	4/28 4/27	5/6 5/26	5/20 6/21	4/25 (All)	5/24 (All)
McNary	Chinook Age 0	All	6/14	6/30	8/4	6/19[f]	7/20[f]
	Chinook Age 1	All	4/18	5/13	5/27	4/23	5/28
	Coho	All	5/21	5/30	6/14	5/6	6/1
	Steelhead	Wild	4/24	5/19	5/31	4/25	5/28
	Steelhead	Hatchery	4/21	5/22	6/1	5/1	5/27
	Sockeye	All	5/6	5/13	5/28	5/4	5/29
John Day	Chinook Age 0	All	6/18	6/29	7/25	6/12[b]	8/15[b]
	Chinook Age 1	All	4/22	5/14	5/31	4/29[b]	5/31[b]
	Coho	All	5/4	5/31	6/13	5/9[b]	5/31[b]
	Steelhead	Wild	4/26	5/23	6/5	4/27[b]	5/26[b]
	Steelhead	Hatchery	5/1	5/28	6/7	5/6[b]	5/28[b]
	Sockeye	All	5/10	5/17	6/1	5/9[b]	6/1[b]

a. Footnotes show number of years of full season data available by species and rearing type categories that were used to determine the historic median 10% and 90% dates: a=9 years (1990-98); b=8 years (1991-98); c=6 years (1993-98); d=3 years (1996-98); e=5years (1990-91 and 1996-98); and f=7 years (1990-98 except 1994 and 1996).

The Lower Granite Dam passage distribution of PIT tagged wild yearling chinook from the Clearwater, Salmon, Imnaha, and Grande Ronde rivers was close to the historic migration dates for the initial 25% of the run (reaching 25% passage around April 22), but passage timing deviated greatly later in the run. The Imnaha River wild yearling chinook reach 75% passage at Lower Granite Dam near May 1, which was 20 days before the Grande Ronde and Salmon River fish, and 40 days before the Clearwater River fish (Figure 20). This is in contrast to the Imnaha River wild steelhead which reached 50% passage at Lower Granite Dam over 20 days later than the wild steelhead runs from the Clearwater, Grande Ronde, and Salmon rivers (Figure 20). Later the Imnaha River wild steelhead caught up with the Salmon and Grande Ronde fish reaching 75% passage around May 22 at Lower Granite Dam. As for hatchery steelhead, the B-run steelhead from the Clearwater River and A-run steelhead from the Salmon River maintained an earlier passage distribution at Lower Granite Dam than the B-run steelhead from the Salmon River and A-run steelhead from the Grande Ronde and Imnaha rivers (Figure 21). Median passage timing at Lower Granite Dam of the hatchery steelhead spanned nearly a month with Clearwater River fish the earliest and Imnaha River fish the latest.

The subyearling chinook migration distribution at Lower Granite Dam had two periods of rapidly increasing passage, the first shortly after the volitional release of nearly 600,000 hatchery subyearling fall chinook from two acclimation ponds, and the second occurring the latter half of July. Hatchery subyearling fall chinook from Captain Johns Rapids acclimation pond had an earlier migration timing than did the fish from Big Canyon Creek acclimation pond (Figure 22). For comparing migration timing among groups of hatchery subyearling fall chinook at Lower Granite Dam, we used only the PIT tagged fish released volitionally with production (excluding the weekly releases made over the season). We also used wild subyearling fall chinook collected and PIT tagged over time at numerous locations in the mainstem Snake River between Asotin and Hells Canyon Dam. The passage timing at Lower Granite Dam of the PIT tagged wild subyearling fall chinook was between that of the fish from the two hatchery acclimation ponds during the period bracketed by the 25% and 75% passage dates (Figure 22).

For fish first entering the lower Columbia River from the Snake River and Mid-Columbia River drainages, McNary Dam is the key site for comparison of migration timing of yearling chinook, steelhead, coho, sockeye, and subyearling chinook from these two drainages. As was observed at Lower Granite Dam, the PIT tagged yearling spring chinook from Lookingglass Hatchery continued to maintain its early passage timing (median before May 3) at McNary Dam compared to the fish from other Snake River drainage hatcheries (Figure 23) and fish from hatcheries in the Mid-Columbia River drainage (Figure 24). The passage timing of PIT tagged Mid-Columbia River origin hatchery yearling chinook (Figure 24) shows an earlier run timing of Winthrop Hatchery fish, followed by Leavenworth Hatchery fish, and then the two Yakima River groups from Clark Flat and Easton acclimation ponds. The passage timing of PIT tagged wild yearling chinook from the four tributaries in the Snake River above Lower Granite dam became closer in time as these fish passed McNary Dam (Figure 25), with only about one week separating the date of median passage of the PIT tagged fish from the Imnaha (early runs) and Clearwater rivers (later runs). PIT tagged wild steelhead from the Clearwater, Grande Ronde, and Salmon rivers maintained their similar passage timing at McNary Dam also, and the later migrating Imnaha wild steelhead retained its later passage timing at McNary Dam (Figure 26). Of interest is how much more rapidly Imnaha River wild steelhead passage numbers increased in the last week of May, going from less than 25% passage on May 22 to over 75% passage in only four days at McNary Dam. PIT tagged sockeye originating in the Snake River drainage did not begin to pass McNary Dam in 1999 until well after 75% of the Mid-Columbia River sockeye had passed that site (Figure 27). Snake River sockeye did not begin to pass McNary until May 25. PIT tagged coho released in the Wenatchee River had an earlier passage distribution at McNary Dam than those released in the Yakima or Clearwater rivers (Figure 28).

The wild subyearling chinook passage distribution at McNary Dam consists mainly of wild fall chinook from the Hanford reach in the Mid-Columbia River and wild fall chinook from the mainstem Snake River. Not all fish are of large enough size to tag when collected on the Hanford reach, consequently the resulting migration timing distribution based on PIT tagged fish in Figure 29 must be viewed as representing larger fish and is likely skewed earlier than the total population of Hanford reach fish. The passage distribution of PIT tagged Snake River origin wild fall chinook shows about 50% of the run passing McNary Dam in August. It is expected that the small non-taggable sized wild fall chinook from the Hanford reach also were passing McNary Dam well into August. PIT tagged fall chinook from Ringold and Priest Rapids hatcheries (Mid-Columbia River) were the earliest hatchery subyearling chinook fish to pass McNary Dam, followed by fish from Captain Johns Rapids acclimation pond (Snake River) and Wells Hatchery (Mid-Columbia River), while fish from Big Canyon Creek acclimation pond (Clearwater River) were the latest fish passing McNary Dam (Figure 30). The date of median passage at McNary Dam spanned over 5 weeks between the Ringold Hatchery and Big Canyon Creek acclimation pond groups.

The passage timing of PIT tagged yearling and subyearling chinook smolts at John Day Dam are earlier for fish originating from the Umatilla River than for smolts originating above McNary Dam. PIT tagged yearling spring chinook released from Imeques acclimation pond passed John Day Dam primarily in the later half of April before the arrival of PIT tagged yearling spring/summer chinook from the Snake and Mid-Columbia River drainages (Figure 31 and Figure 32). Except for PIT tagged Lookingglass Hatchery spring chinook, the passage distribution at John Day Dam of most upriver hatchery spring/summer stocks did not get underway until after May 5. The passage of PIT tagged subyearling fall chinook released from Imeques acclimation pond at John Day Dam began to increase rapidly after June 15, a week before the arrival of PIT tagged hatchery subyearling chinook originating above McNary Dam (Figure 33). The latest arriving PIT tagged subyearling chinook at John Day Dam were from Wells Hatchery. Although the Wells Hatchery summer chinook did not begin passing John Day Dam until July 1, they caught up with the subyearling fall chinook from Big Canyon Creek and Captain John Rapids acclimation ponds at the time of 50% and 75% passage, respectively, in late July (Figure 33). The John Day Dam passage distributions of wild yearling chinook (Figure 34), wild steelhead (Figure 35), total sockeye (Figure 36), and total coho (Figure 37) didn't differ much from that at McNary Dam except in being shifted later as expected.

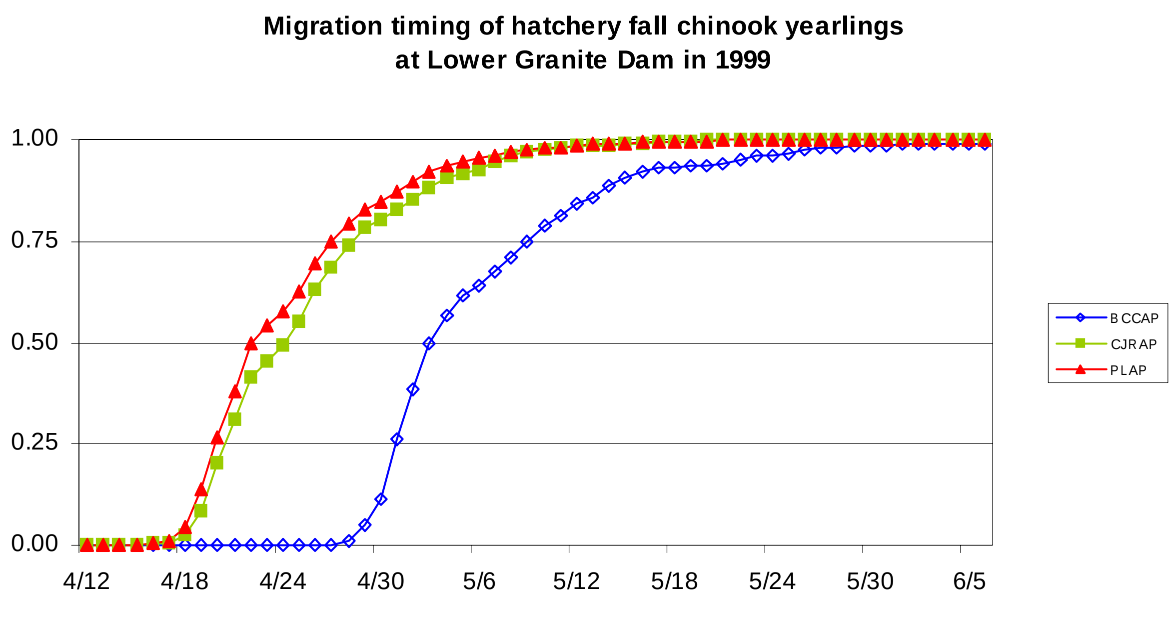


FIGURE 17. Migration timing of hatchery fall chinook yearling at Lower Granite Dam in 1999 (Legend: BCCAP = Big Canyon Creek AP; CJRAP = Captain John Rapids AP; and PLAP = Pittsburg Landing AP)

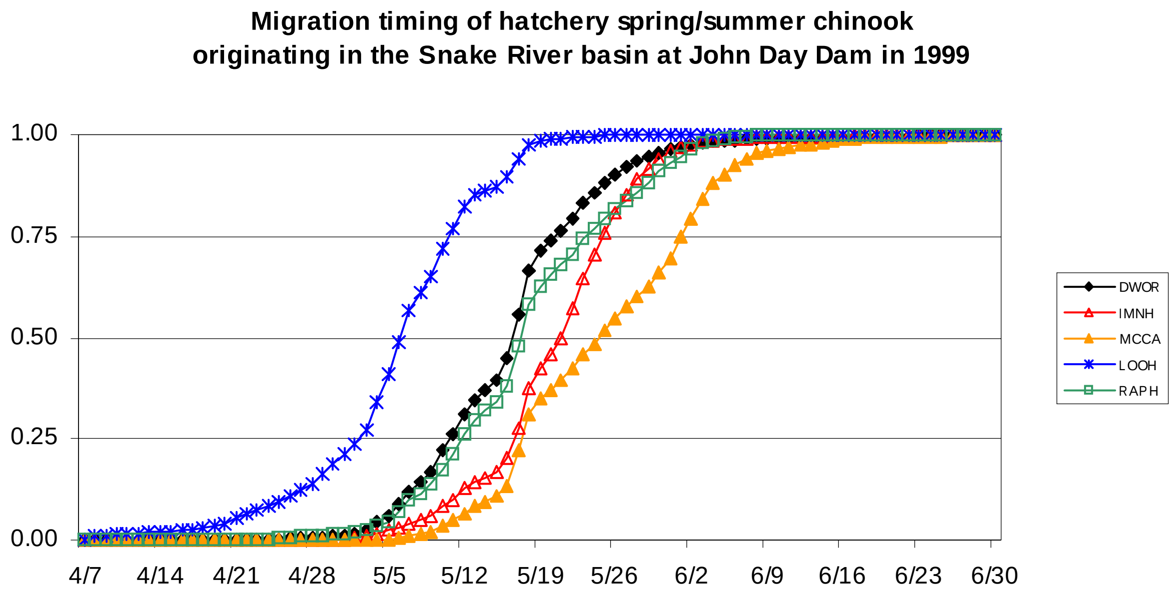


FIGURE 18. Migration timing of hatchery spring/summer chinook at Lower Granite Dam in 1999. (Legend: DWOR = Dworshak NFH; IMNH = Imnaha AP; MCCA = McCall SFH; LOOH = Lookingglass SFH; and RAPH = Rapid River SFH)

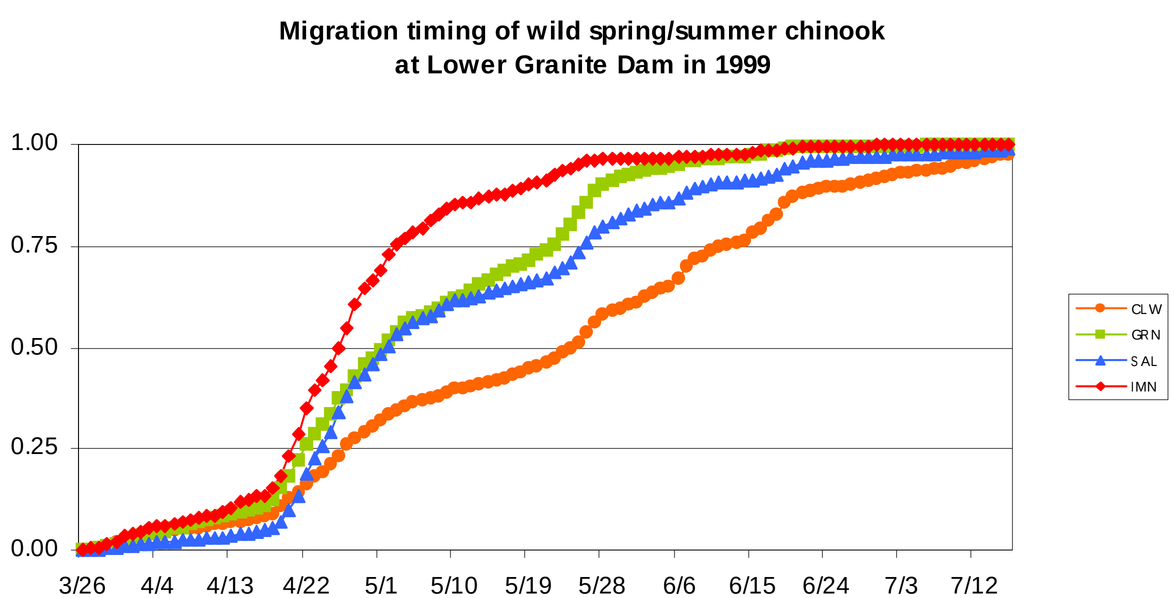


FIGURE 19. Migration timing of wild spring/summer chinook at Lower Granite Dam in 1999. (Legend: CLW = Clearwater R basin; GRN = Grande Ronde R basin; SAL = Salmon R basin; and IMN = Imnaha R basin)

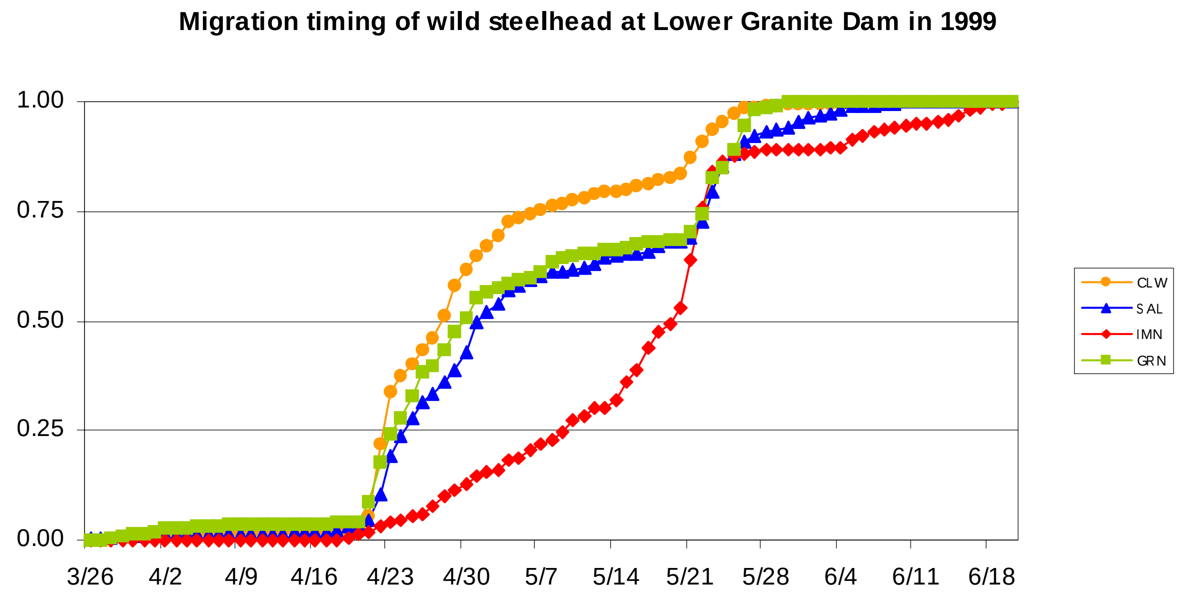


FIGURE 20. Migration timing of wild steelhead at Lower Granite Dam in 1999. (Legend: CLW = Clearwater R basin; GRN = Grande Ronde R basin; SAL = Salmon R basin; and IMN = Imnaha R basin)

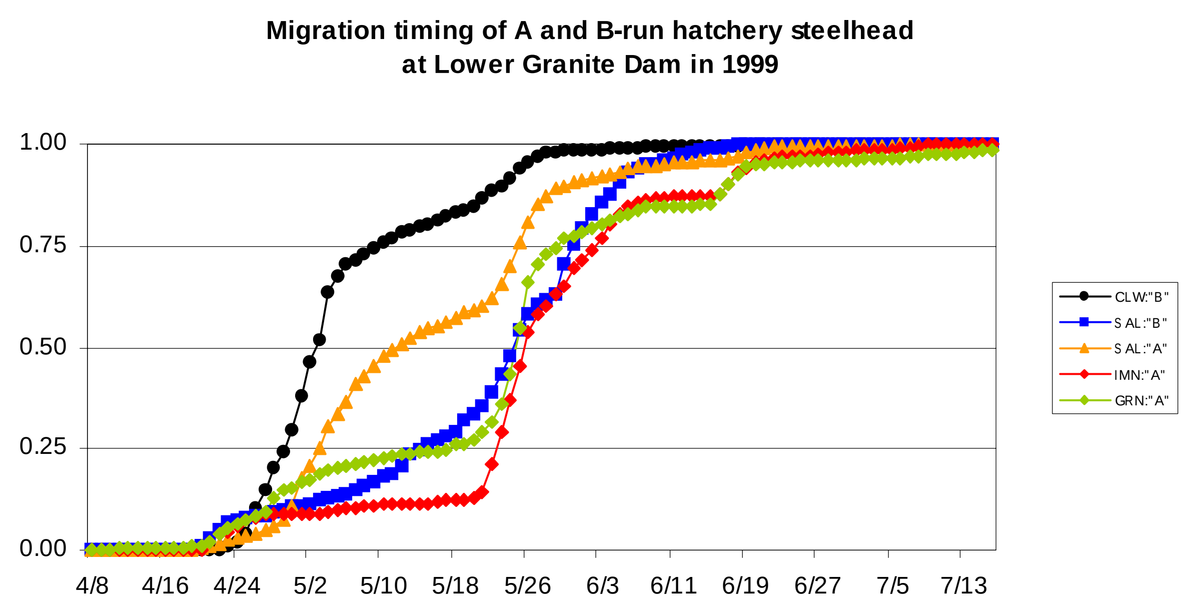


FIGURE 21. Migration timing of A and B-run hatchery steelhead at Lower Granite Dam in 1999. (Legend: CLW "B" = Clearwater R basin B-run; SAL "V" = Salmon R basin B-run; SAL "A" = Salmon R basin A-run; IMN "A" = Imnaha R basin A-run; and GRN "A" = Grande Ronde R basin A-run)

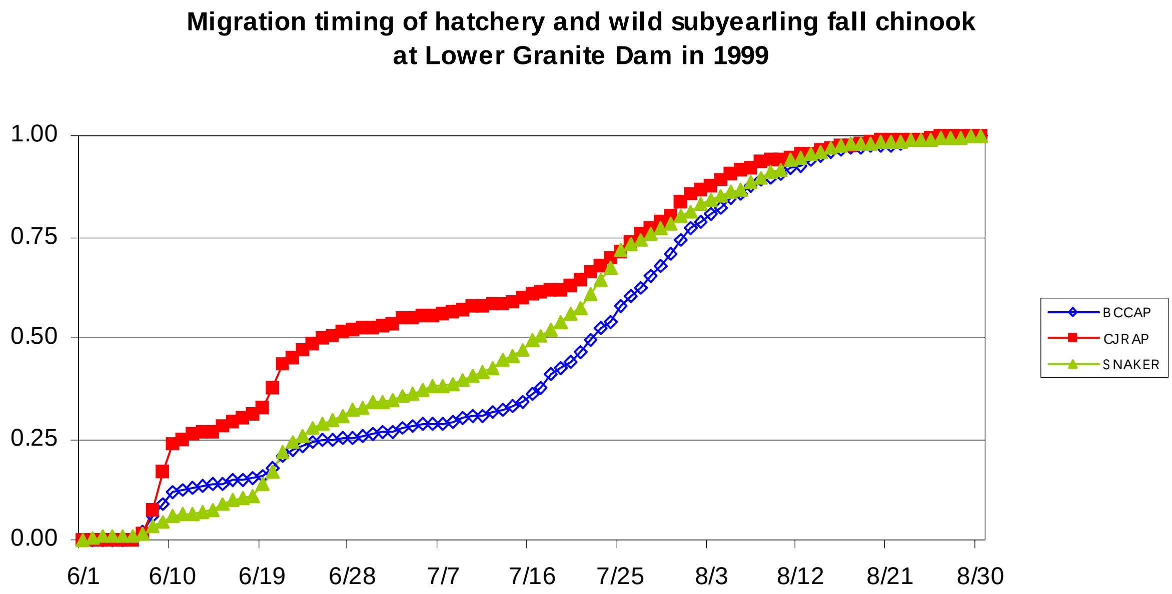


FIGURE 22. Migration timing of hatchery and wild subyearling fall chinook at Lower Granite Dam in 1999. (Legend: BCCAP = Big Canyon Creek AP {hatchery fish}; CJRAP = Captain John Rapids AP {hatchery fish}; and SNAKER = mainstem Snake R {wild fish})

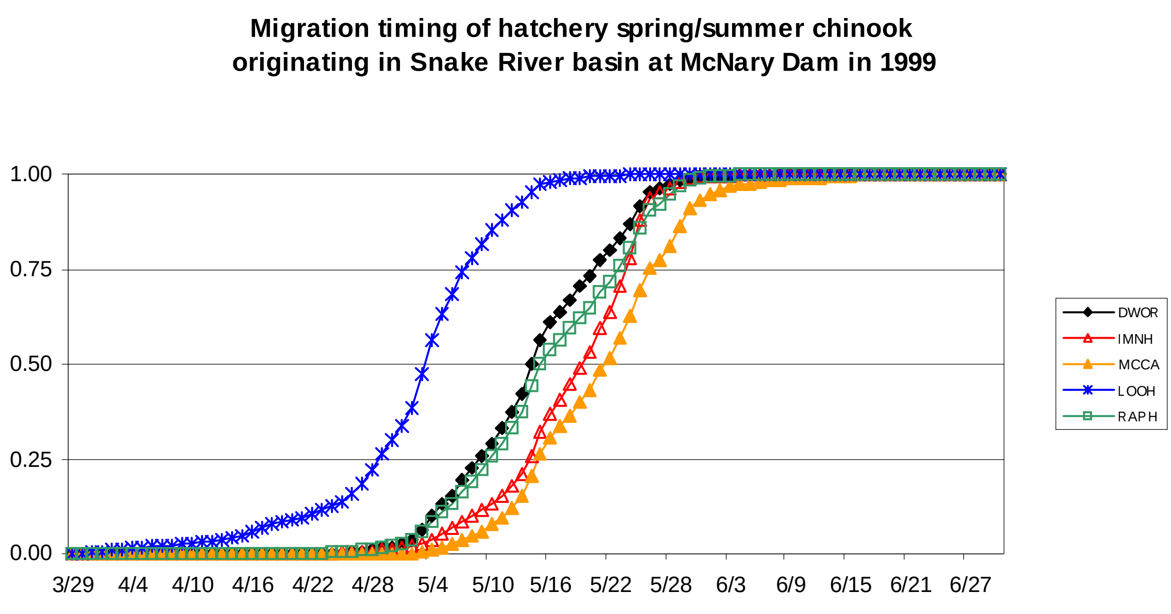


FIGURE 23. Migration timing of hatchery spring/summer chinook originating in Snake River basin at McNary Dam in 1999 (Legend: DWOR = Dworshak NFH; IMNH = Imnaha AP; MCCA = McCall SFH; LOOH = Lookingglass SFH; and RAPH = Rapid River SFH)

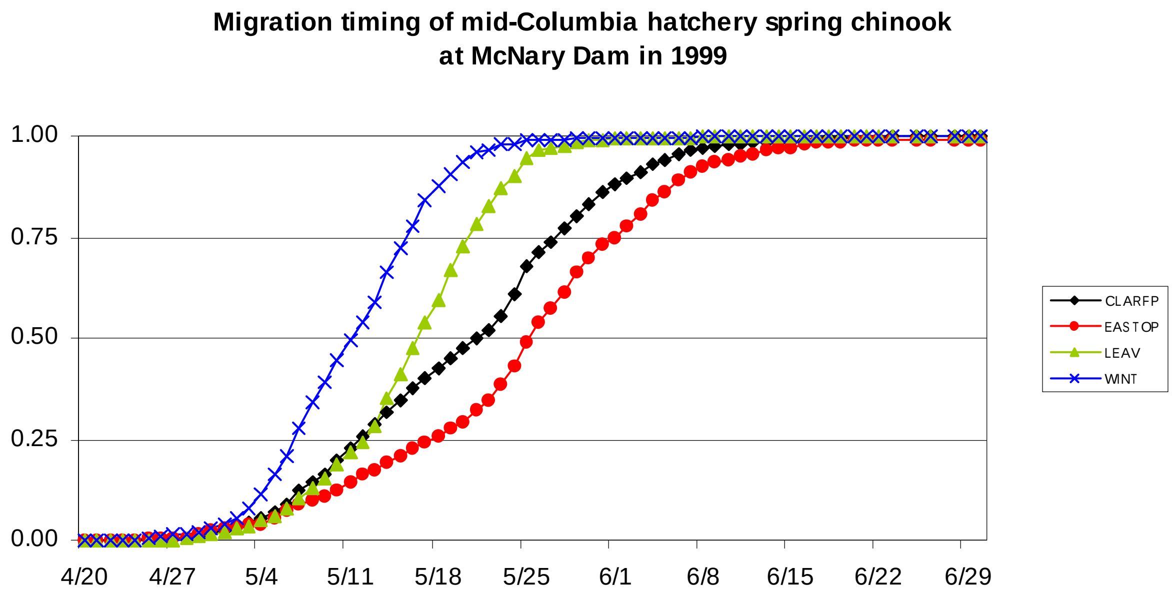


FIGURE 24. Migration timing of mid-Columbia hatchery spring chinook at McNary Dam in 1999. (Legend; CLARFP = Clark Flat AP {Yakima R basin}; EASTOP = Easton AP {Yakima R basin}; LEAV = Leavenworth NFH; and WINT = Winthrop NFH)

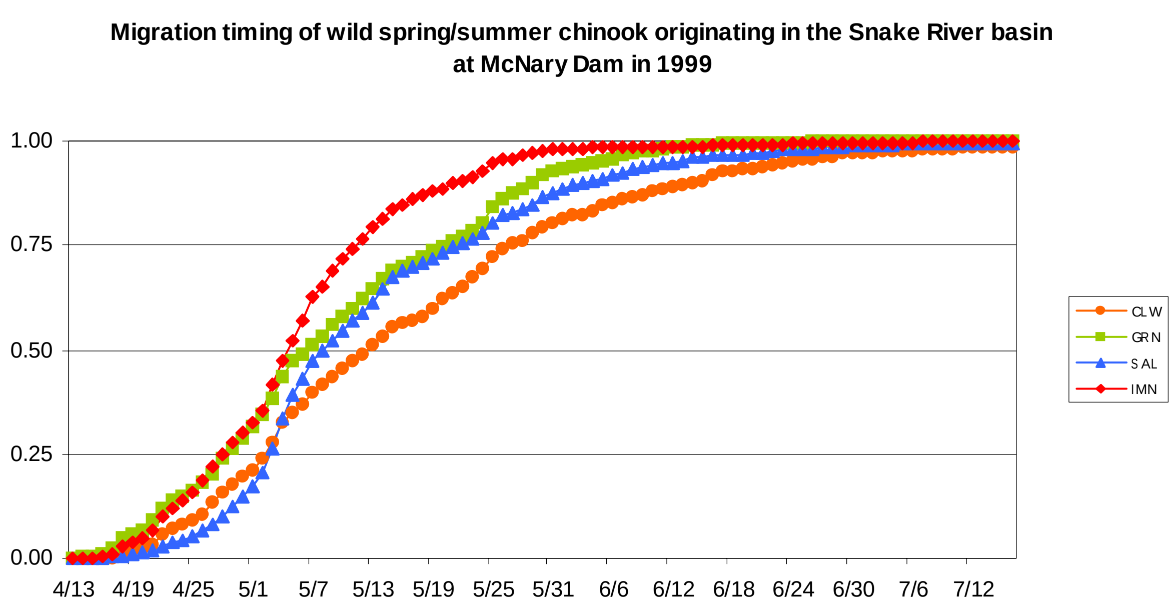


FIGURE 25. Migration timing of wild spring/summer chinook originating in the Snake River basin at McNary Dam in 1999. (Legend: CLW = Clearwater R basin; GRN = Grande Ronde R Basin; SAL = Salmon R basin; and IMN = Imnaha R basin)

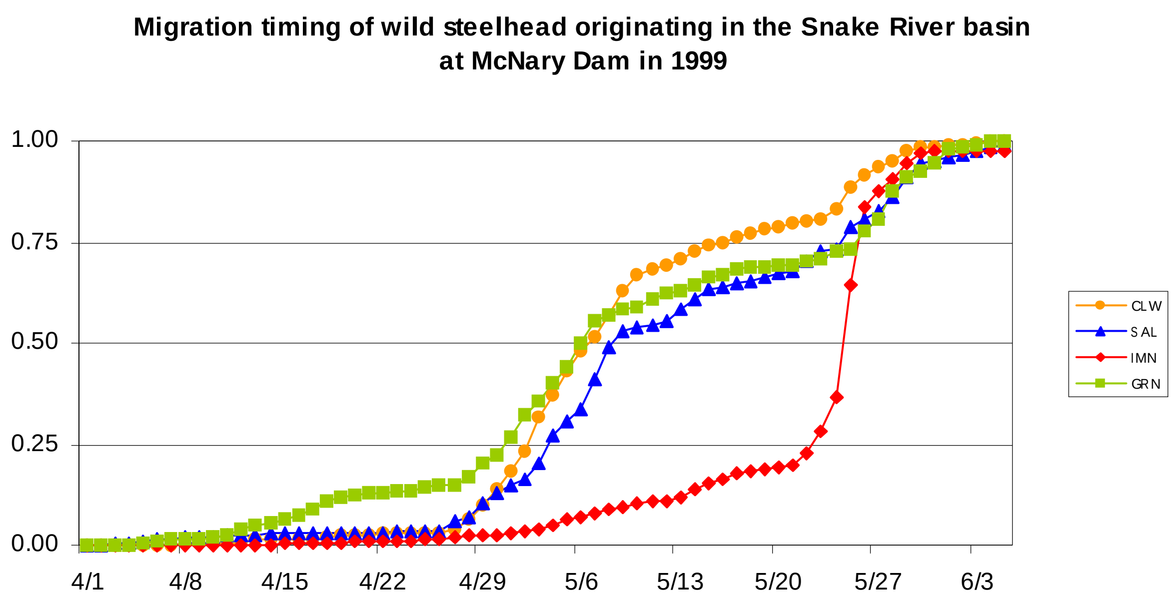


FIGURE 26. Migration timing of wild steelhead originating in the Snake River basin at McNary Dam in 1999. (Legend: CLW = Clearwater R basin; GRN = Grande Ronde R basin; SAL = Salmon R basin; and IMN = Imnaha R basin)

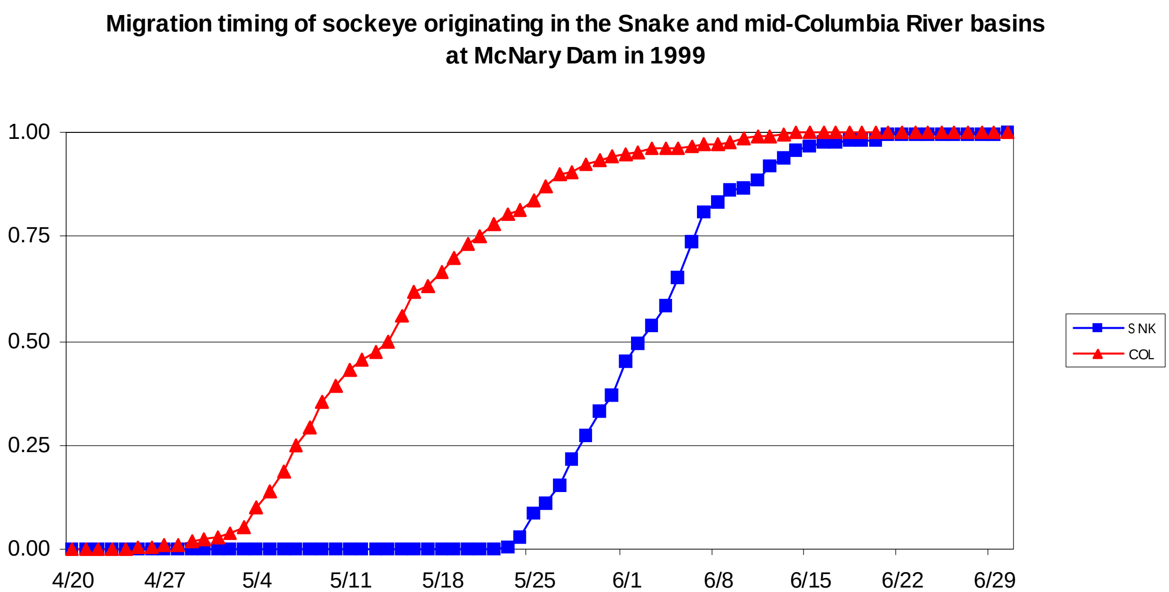


FIGURE 27. Migration timing of sockeye originating in the Snake and mid-Columbia River basins at McNary Dam in 1999. (Legend: SNK = Snake R basin and COL= Mid-Columbia R basin)

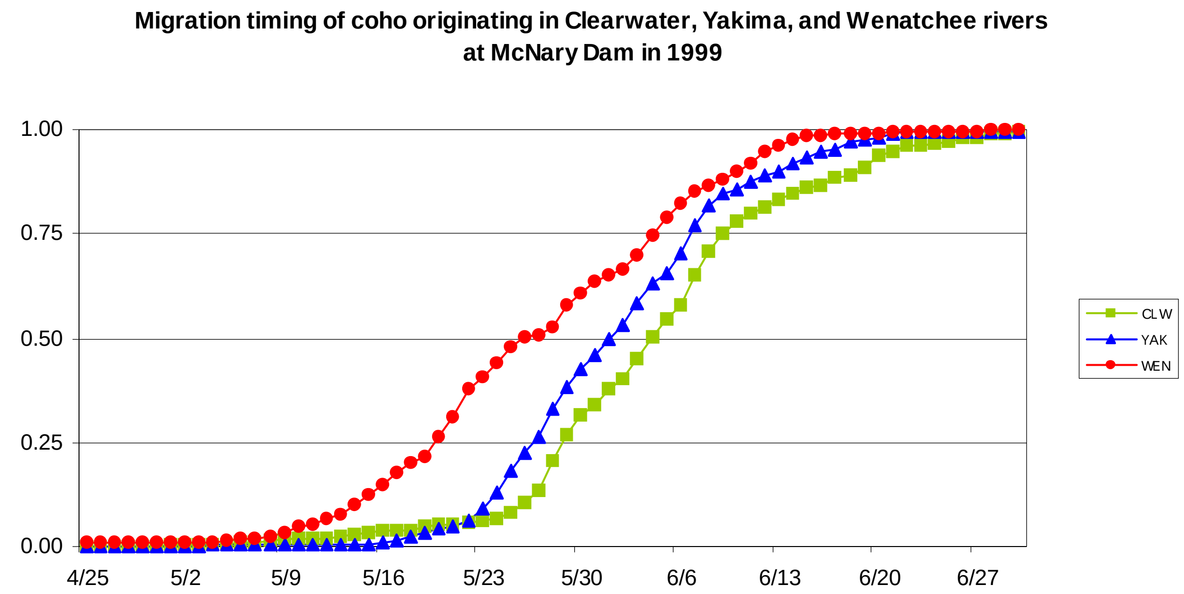


FIGURE 28. Migration timing of coho originating in Clearwater, Yakima, and Wenatchee rivers at McNary Dam in 1999. (Legend: CLW = Clearwater R {Snake R basin}; YAK = Yakima R and WEN = Wenatchee R {Mid-Columbia R basin})

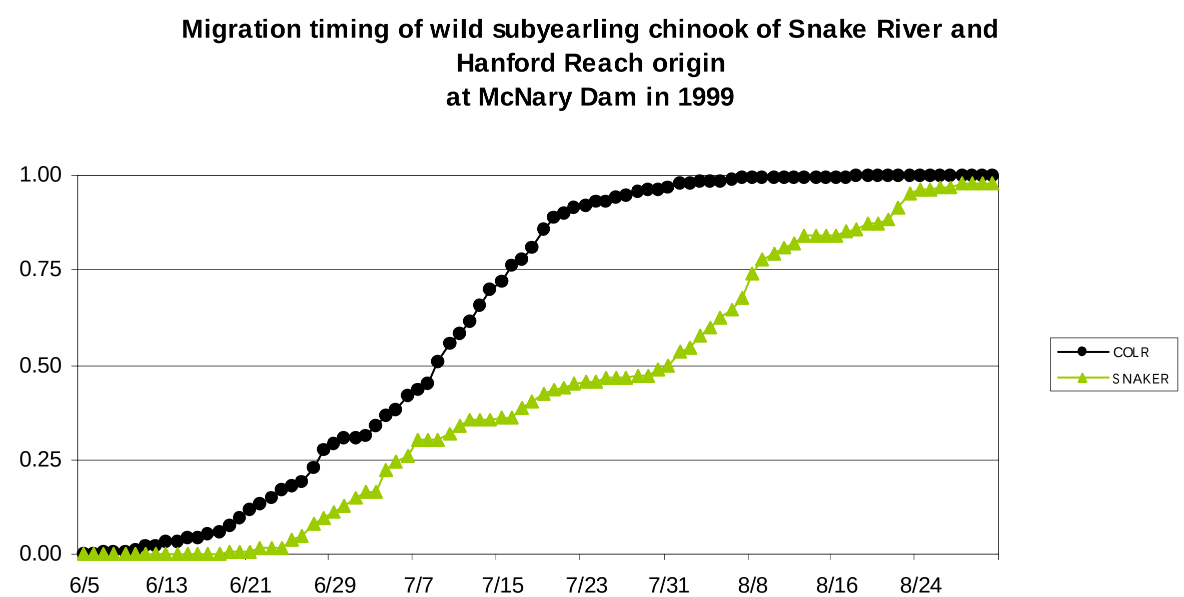


FIGURE 29. Migration timing of wild subyearling chinook of Snake River and Hanford Reach origin at McNary Dam in 1999. (Legend: COLR = Mainstem Mid-Columbia R Hanford Reach and SNAKER = mainstem Snake R)

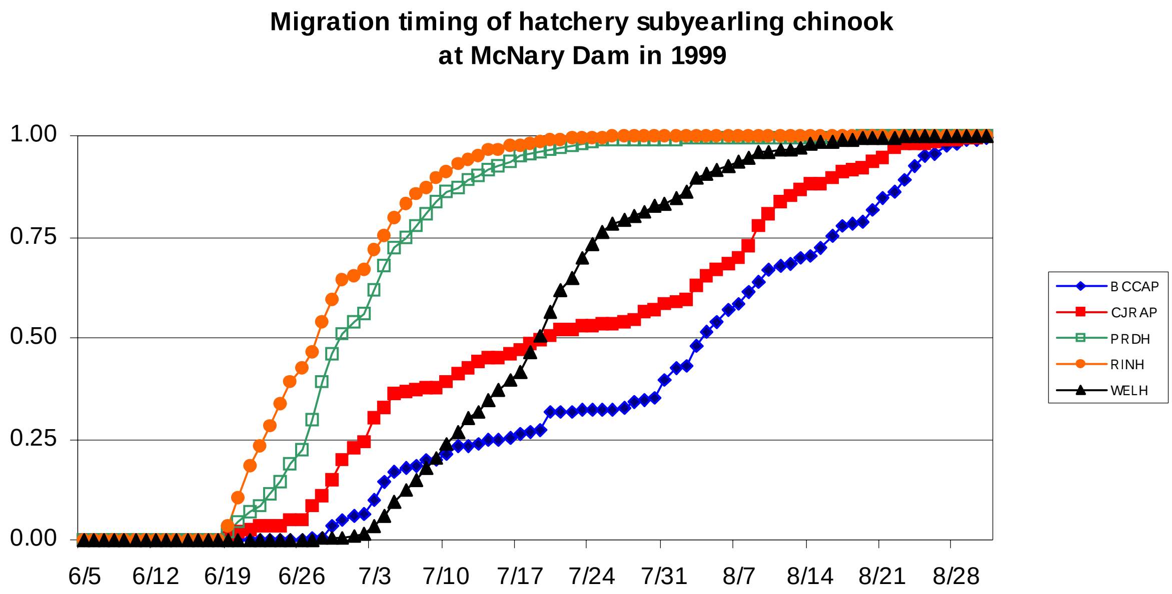


FIGURE 30. Migration timing of hatchery subyearling chinook at McNary Dam in 1999. (Legend: BCCAP = Big Canyon Creek AP and CJRAP = Captain John Rapids AP {Snake R basin}; PRDH = Priest Rapids SFH; RINH = Ringold SFH; and WELH = Well SFH {Mid-Columbia R basin})

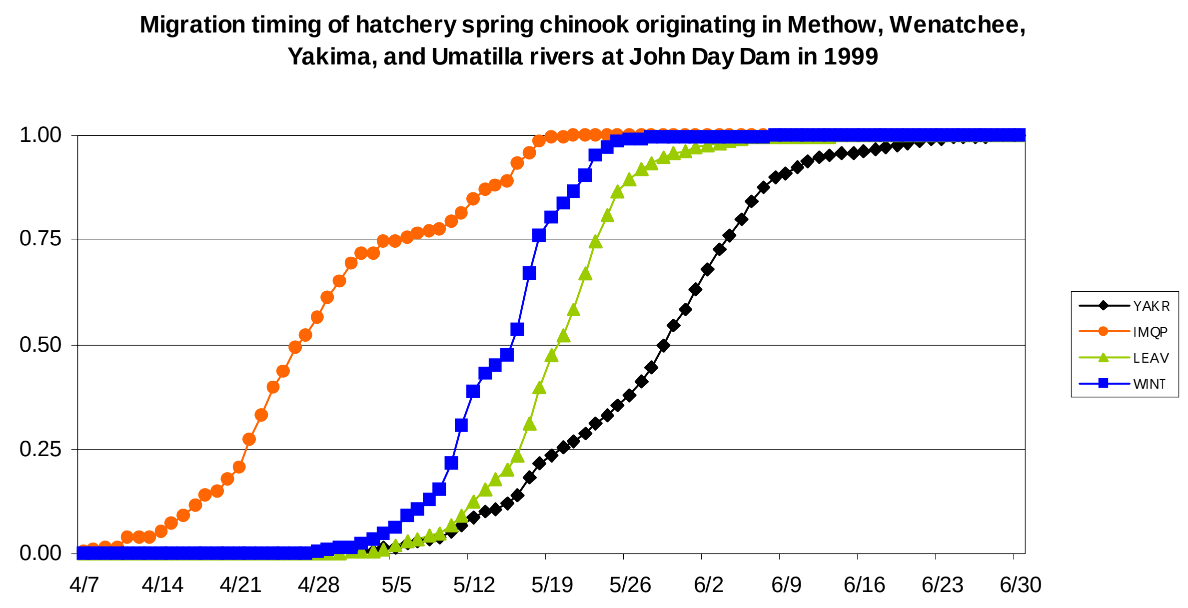


FIGURE 31. Migration timing of hatchery spring chinook originating in Methow, Wenatchee, Yakima, and Umatilla Rivers at John Day Dam in 1999. (Legend: YAKR = Yakima R; LEAV = Leavenworth NFH; and WINT = Winthrop NFH {Mid-Columbia R basin}; and IMQP = Imeques AP {Umatilla R basin})

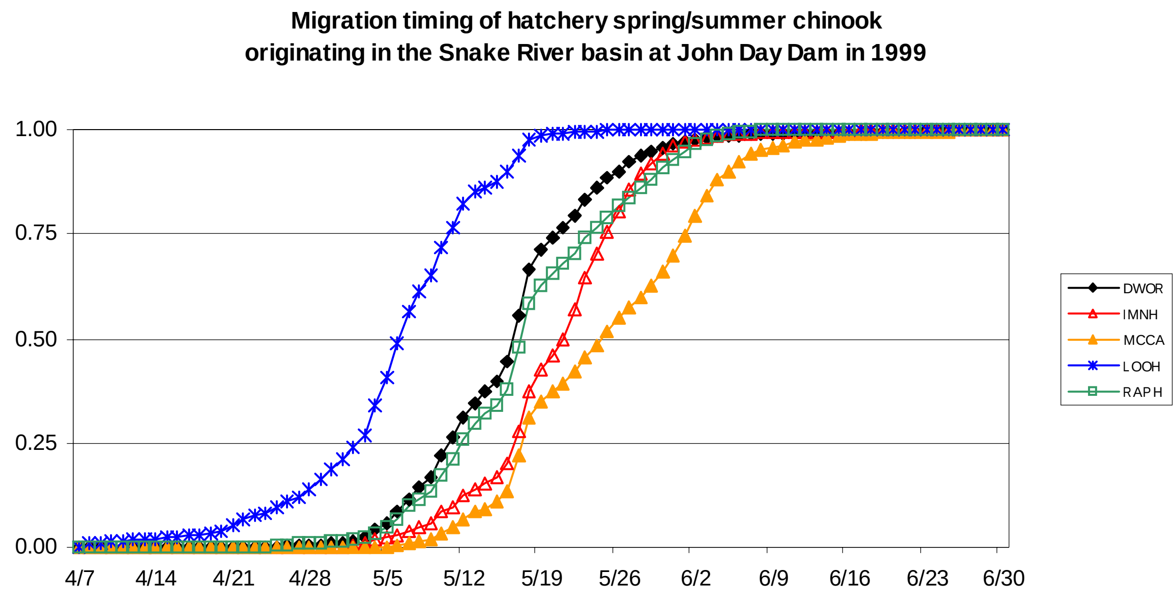


FIGURE 32. Migration timing of hatchery spring/summer chinook originating in the Snake River basin at John Day Dam in 1999. (Legend: DWOR = Dworshak NFH; IMNH = Imnaha AP; MCCA = McCall SFH; LOOH = Lookingglass SFH; and RAPH = Rapid River SFH)

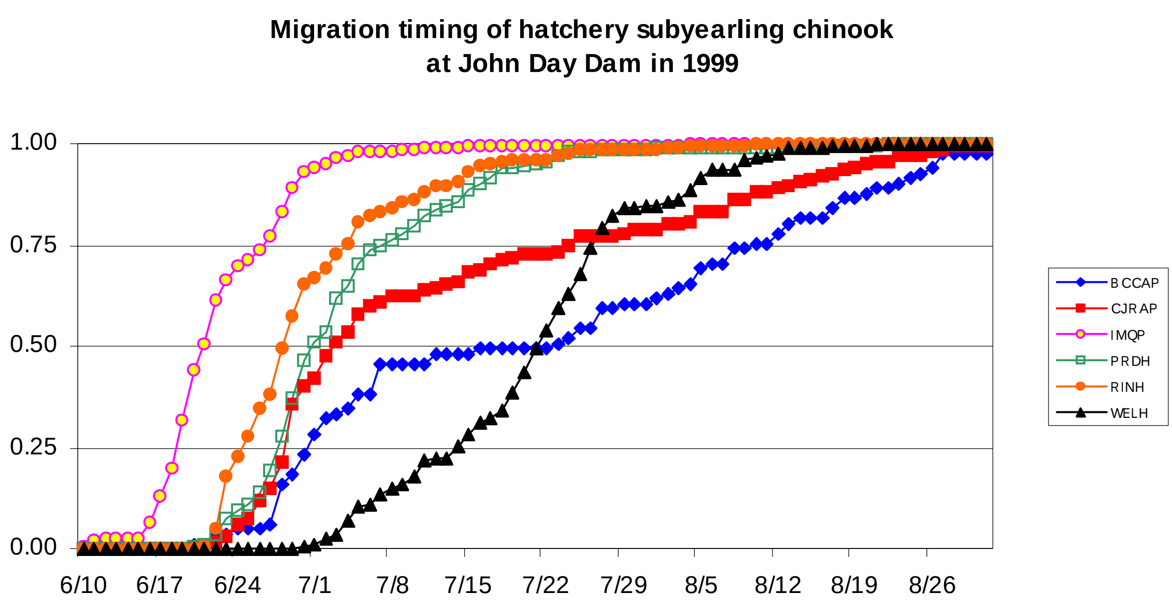


FIGURE 33. Migration timing of hatchery subyearling chinook at John Day Dam in 1999. (Legend: BCCAP = Big Canyon Creek AP and CJRAP - Captain John Rapids AP {Snake R basin}; IMQP = Imeques AP {Umatilla R basin}; PRDH = Priest Rapids SFH; RINH = Ringold SFH; and WELH = Well SFH {Mid-Columbia R basin})

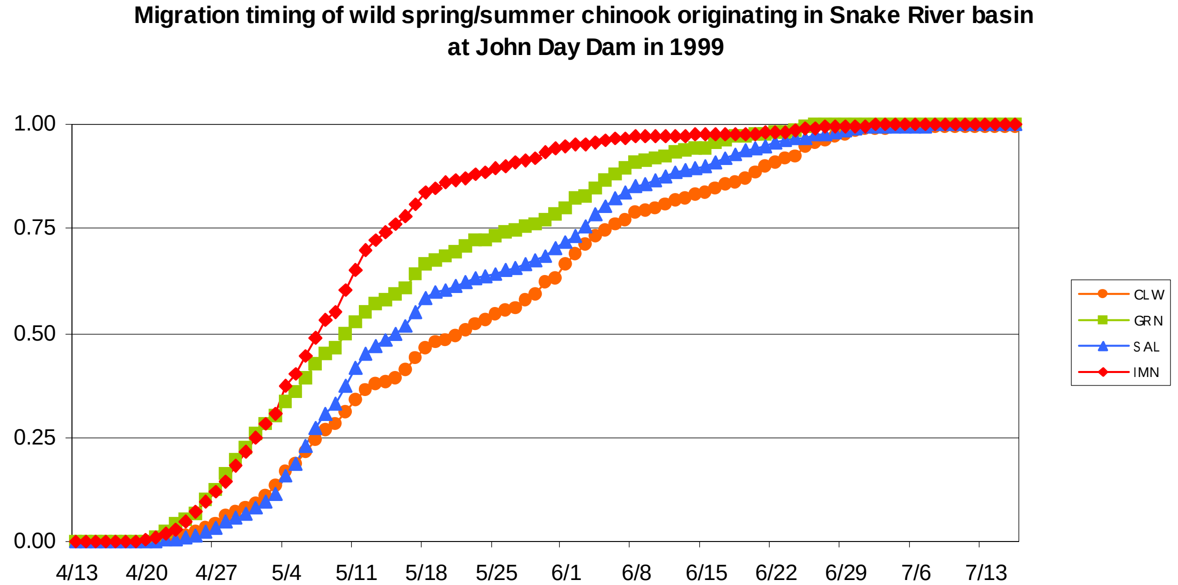


FIGURE 34. Migration timing of wild spring/summer chinook originating in Snake River basin at John Day Dam in 1999. (Legend: CLW= Clearwater R basin; GRN = Grande Ronde R basin; SAL = Salmon R basin; and IMN = Imnaha R basin)

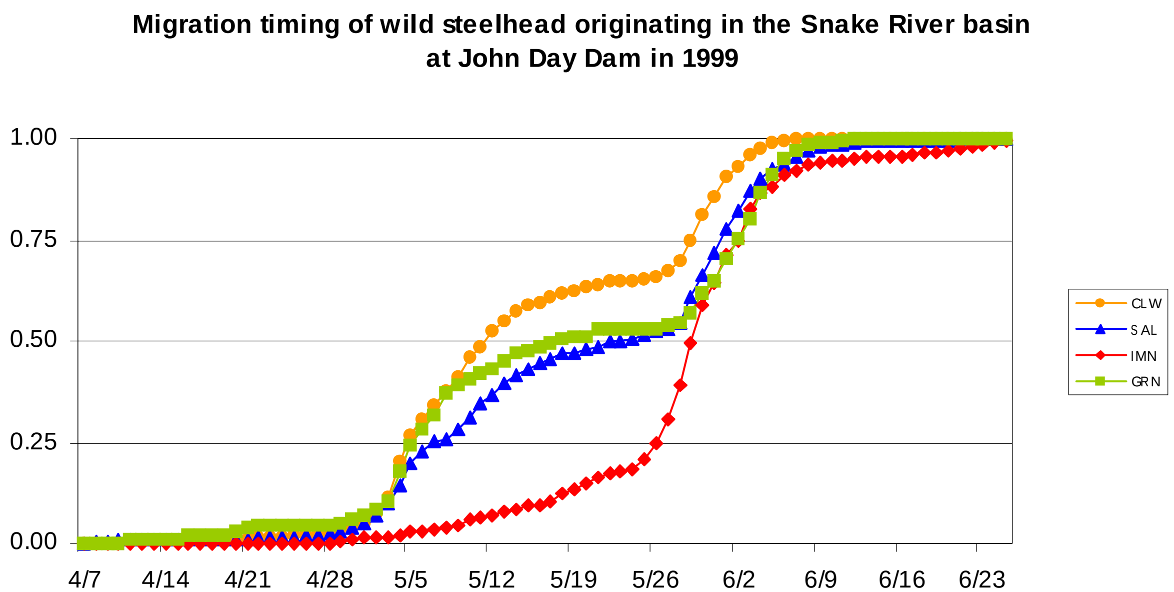


FIGURE 35. Migration timing of wild steelhead originating in the Snake River basin at John Day Dam in 1999. (Legend: CLW = Clearwater R basin; GRN = Grande Ronde R basin; SAL = Salmon R basin; and IMN = Imnaha R basin})

Migration timing of sockeye originating in the Snake and mid-Columbia River basins at John Day Dam in 1999

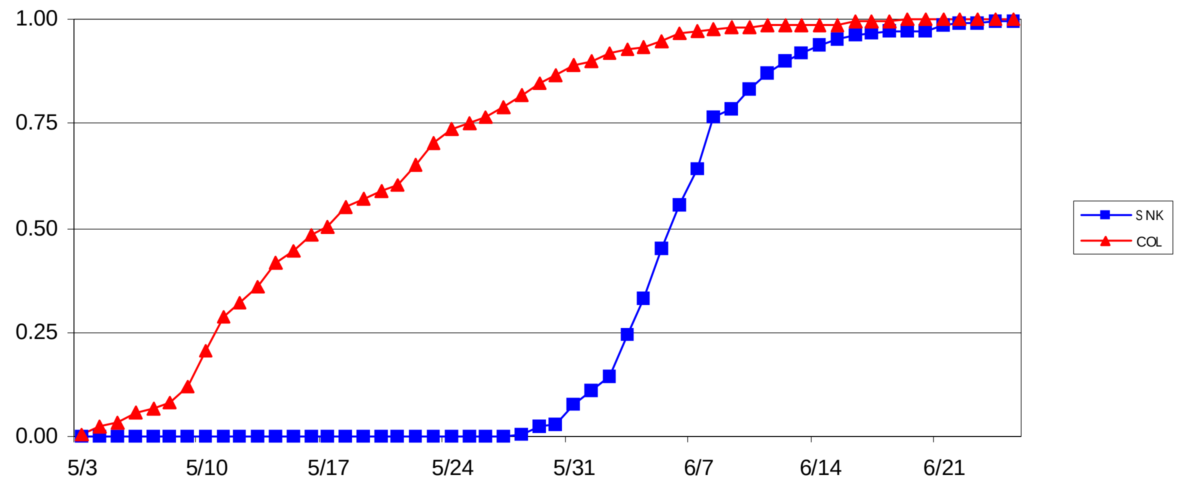


FIGURE 36. Migration timing of sockeye originating in the Snake and mid-Columbia R basin)

Migration timing of coho originating in Clearwater, Yakima, and Wenatchee rivers at John Day Dam in 1999

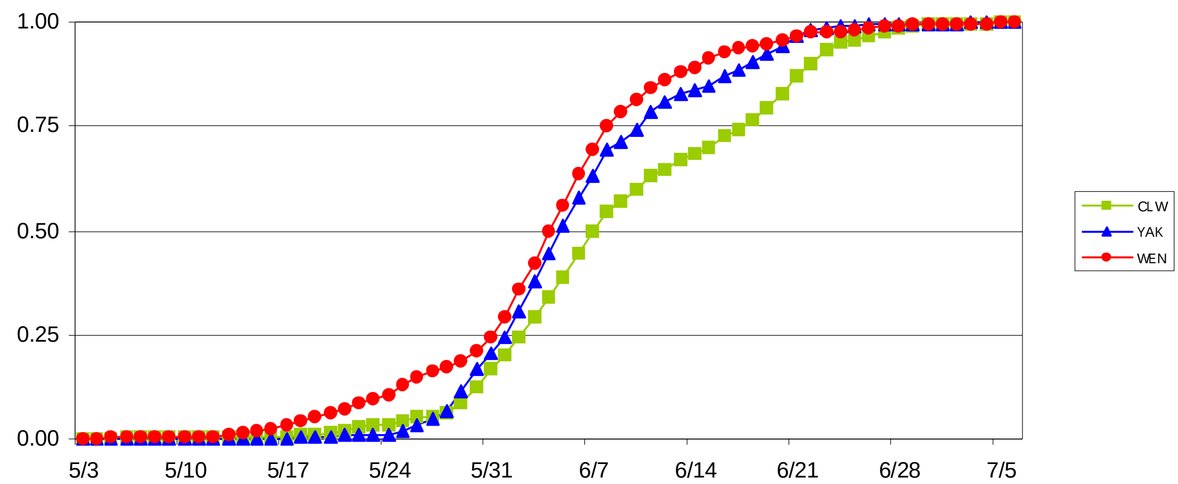


FIGURE 37. Migration timing of coho originating in Clearwater, Yakima, and Wenatchee rivers at John Day Dam in 1999 (Legend: CLW=Clearwater R [Anake R basin];YAK=Yakima R and WEN=Wenatchee R [Mid-Columbia R basin])

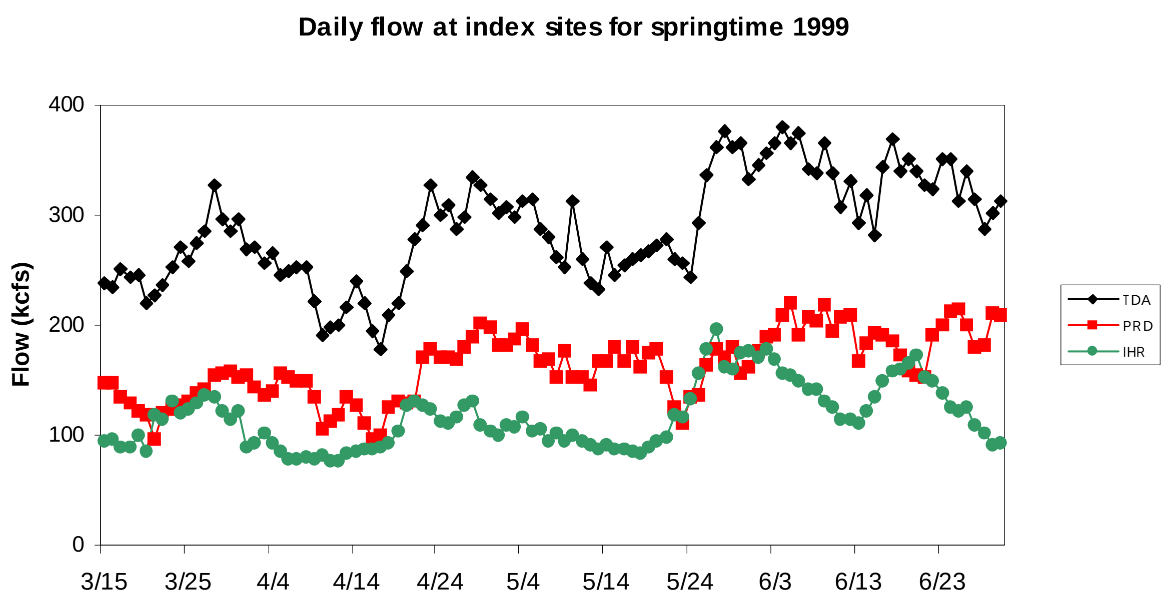


FIGURE 38. Daily flow at index sites of The Dalles Dam (TDA), Priest Rapids Dam (PRD), and Ice Harbor Dam (IHR) during the springtime of 1999.

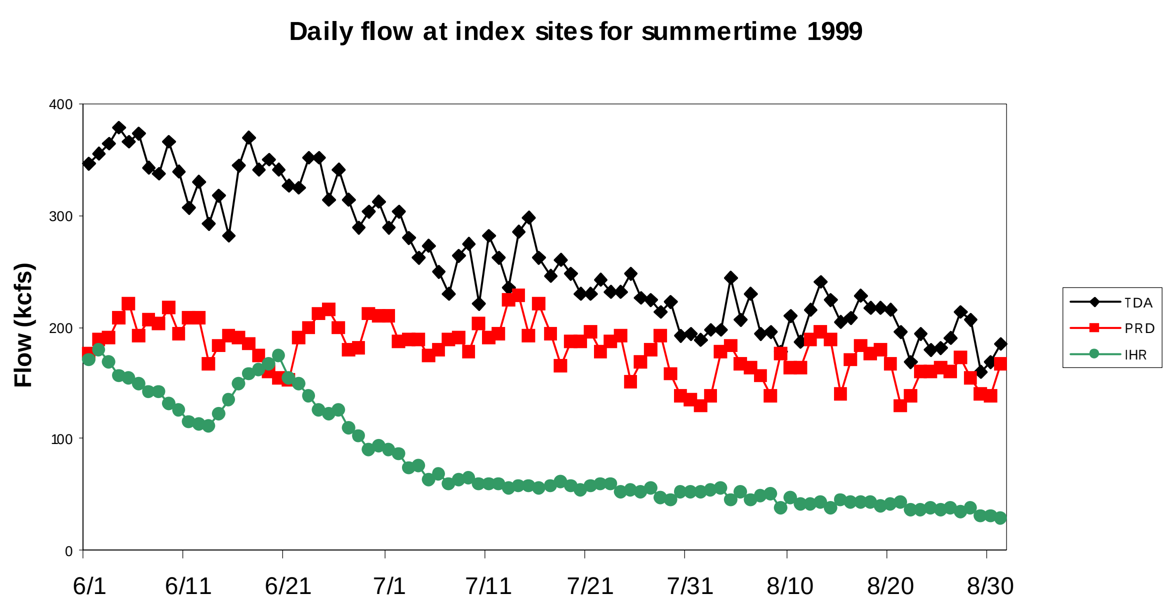


FIGURE 39. Daily flow at index sites of The Dalles Dam (TDA), Priest Rapids Dam (PRD), and Ice Harbor Dam (IHR) during the summertime of 1999.

D. Travel Time.

The PIT tag provides an unique alphanumeric code for individual fish which allows the determination of date and time of passage of these fish at dams outfitted with PIT tag detection equipment. From these data, travel times of individual fish within reaches of interest may be computed. Travel time is estimated from release to first detection site, and between series of dams, by subtracting the upstream detection date and time from the downstream detection date and time for PIT tagged fish. From the distribution of travel times for each group of PIT tagged fish, a series of summary statistics are computed. In the main body of the text, the average travel time for various groupings of fish are presented.

As has been presented in past annual reports, a series of tables are found in Appendix G providing data on minimum, maximum, and median travel time with associated 95% confidence intervals for groups of fish, and flow and river temperature averages. These environmental parameters are computed at a key dam within the reach of interest as the average across a series of days equal to the number of days estimated as the median travel time. This series of days begins with the date of release for travel times estimated from release to first monitoring site (*e.g.*, Snake River basin sites to Lower Granite Dam or Mid-Columbia River basin sites to McNary Dam), and with the date of re-release at the upstream dam for travel times estimated between two dams (*e.g.*, Lower Granite Dam to McNary Dam, Rock Island to McNary Dam, and McNary Dam to Bonneville Dam). Travel time estimates for groups of PIT tagged fish released from the four traps, selected hatcheries, Hanford reach, and Rock Island Dam or re-released from Lower Granite and McNary dams are presented in Appendix G.

1. Lower Granite Dam to McNary Dam Index Reach

Travel time of smolts between Lower Granite and McNary dams was estimated using smolts PIT tagged at five hatcheries and at four traps located in the tributaries above Lower Granite Dam. For yearling chinook released from Dworshak, Imnaha, McCall, Lookingglass, and Rapid River hatcheries, most PIT tagged fish were passing Lower Granite Dam between April 20 and May 31. Some early migrating fish from Lookingglass Hatchery were present at Lower Granite Dam as early as March 25. The average travel time within weekly blocks of passage at Lower Granite Dam are presented for these hatchery groups in Table 37. Groups with less than

10 fish in a block do not have average travel times presented. For all groups, average travel time was lowest during weeks 8 and 9 (May 18 to May 31), the periods when the flows increased to their highest springtime level in the Snake River (Figure 38). During this period, average travel time of hatchery yearling chinook was centered around 7 days. The hatchery yearling chinook's weekly average travel times had dropped from 13.5 days to around 9 days from weeks 1 to 7 (March 25 to May 17). The same decreasing trend in average Lower Granite to McNary Dam travel times was observed for hatchery and wild chinook and hatchery steelhead PIT tagged at the four traps in the tributaries above Lower Granite Dam (Table 38). Wild steelhead's average travel time between Lower Granite Dam and McNary Dam remained lower than that of the other smolts across the season, and also reached its lowest average travel times during the period of highest flows.

TABLE 37. Average travel time for Snake River basin hatchery yearling chinook from Lower Granite Dam to McNary Dam in 1999, grouped by week of passage at Lower Granite Dam.

Week	Lower Granite Date range	Average travel time in days (sample number in parenthesis)					
		Dworshak	Imnaha	McCall	Lookingglass	Rapid River	Total
1	3/25 – 3/31		n.a. (1)		13.4 (33)		13.5 (34)
2	4/1 – 4/12				12.2 (15)		12.2 (15)
3	4/13 – 4/19	n.a. (3)	n.a. (4)		11.9 (41)	n.a. (2)	12.3 (50)
4	4/20 – 4/26	12.7 (51)	11.4 (21)	n.a. (9)	10.7 (205)	12.2 (82)	11.4 (368)
5	4/27 – 5/3	11.7 (133)	12.1 (69)	12.3 (52)	10.6 (145)	11.0 (188)	11.3 (587)
6	5/4 – 5/10	10.3 (79)	10.7 (78)	10.6 (70)	9.5 (22)	10.0 (125)	10.3 (374)
7	5/11 – 5/17	10.0 (21)	9.6 (77)	8.9 (76)	n.a. (1)	8.9 (90)	9.2 (265)
8	5/18 – 5/24	7.6 (14)	7.2 (23)	6.8 (49)	n.a. (1)	6.9 (53)	7.0 (140)
9	5/25 – 5/31	6.5 (11)	n.a. (2)	7.0 (44)		5.1 (13)	6.7 (70)
Total		11.1 (312)	10.5 (275)	9.4 (300)	11.0 (463)	10.1 (553)	10.4 (1903)

Note: average travel time not shown for samples of less than 10 fish.

TABLE 38. Average travel time from Lower Granite Dam to McNary Dam in 1999 for combined PIT tagged fish release from traps on the Salmon, Snake, Imnaha, and Grande Ronde rivers, grouped by passage period at Lower Granite Dam.

Block	Lower Granite Date range	Average travel time (days)		Number of fish	
		Steelhead		Steelhead	
		Hatchery	Wild	Hatchery	Wild
1	4/18-4/24	16.1	8.4	88	33
2	4/25-5/1	11.0	8.2	76	36
3	5/2-5/15	12.1	8.9	98	37
4	5/16-5/22	8.0	6.9	81	49
5	5/23-5/30	6.4	5.2	127	32
6	6/13--6/20	5.7	n.a.	22	3
Block	**Lower Granite Date range**	**Chinook**		**Chinook**	
		Hatchery	**Wild**	**Hatchery**	**Wild**
1	3/26-4/17	13.7	17.2	35	108
2	4/18-4/24	11.6	11.5	89	221
3	4/25-5/1	11.0	10.4	144	250
4	5/2-5/8	10.4	9.9	158	136
5	5/9-5/15	9.7	10.0	98	45
6	5/16-5/30	7.0	7.7	95	62

2. Snake River Basin Smolts in McNary Dam to Bonneville Dam Index Reach

Travel time of Snake River basin smolts between McNary and Bonneville dams was estimated using smolts PIT tagged at hatcheries and traps in the tributaries above Lower Granite Dam. For yearling chinook released from Dworshak, Imnaha, McCall, Lookingglass, and Rapid River hatcheries, most PIT tagged fish were passing Lower Granite Dam between May 4 and May 31. Some early migrating fish from Lookingglass Hatchery were present at McNary Dam throughout April. The average travel time within 1-2 week blocks of passage at McNary Dam are presented for these hatchery groups in Table 39. Groups with less than 10 fish in a block do not have average travel times presented. For all groups, average travel time was lowest during blocks 6 and 7 (May 18 to May 31) and additionally in Block 8 (June 1-15) for late migrating McCall Hatchery fish. These were periods when the flows increased to their highest springtime level in the lower Columbia River (Figure 22). During this period, average travel time of hatchery yearling chinook was centered around 4-5 days. The hatchery yearling chinook's weekly average travel times had dropped from 7 to around 5.2 days from blocks 1 to 5 (April 3 to May 17). The same decreasing trend in average Lower Granite to McNary Dam travel times was observed for hatchery and wild chinook and hatchery (and, to a lesser degree, wild) steelhead PIT tagged at the four traps in the tributaries above Lower Granite Dam (Table 40). After May 25 when flows began to increase to their highest levels for the springtime in the lower Columbia River, average travel time between McNary Dam and Bonneville Dam averaged 4 days for hatchery and wild chinook and closer to 5 days for hatchery and wild steelhead.

3. Mid-Columbia River Basin Smolts in McNary Dam to Bonneville Dam Index Reach

Travel time of Mid-Columbia River basin smolts between McNary and Bonneville dams was estimated using smolts PIT tagged at hatcheries, Rock Island Dam, and the Hanford reach in the Mid-Columbia River basin. The average travel times of yearling chinook from Winthrop and Leavenworth hatcheries, grouped by weekly blocks of passage at McNary Dam, are presented in Table 41. Within the McNary Dam to Bonneville Dam index reach, the average travel time for these hatchery chinook was lowest during block 4 (May 20 to May 26), the period when the flows increased to their highest springtime level in the lower Columbia River (Figure 38). During this period, average travel time of hatchery yearling chinook was centered around 5 days, similar to what was measured for Snake River basin hatchery chinook around that time. Even though fish from Leavenworth and Winthrop hatcheries that entered the lower Columbia River later migrated faster through that reach, their overall travel time to Bonneville Dam was longer because of the time taken to arrive at McNary Dam.

TABLE 39. Average travel time for Snake River basin hatchery yearling chinook from McNary Dam to Bonneville Dam in 1999, grouped by passage period at McNary Dam.

Block	McNary Date range	Average travel time in days. (sample number in parenthesis)					
		Dworshak	Imnaha	McCall	Lookingglass	Rapid River	Total
1	4/3 - 4/19				7.1 (64)		7.1 (64)
2	4/20 - 4/26	n.a. (5)	n.a. (1)		6.0 (68)	n.a. (6)	6.0 (80)
3	4/27 - 5/3	6.6 (82)	5.8 (14)	n.a. (3)	6.2 (300)	6.3 (59)	6.3 (458)
4	5/4 - 5/10	6.9 (286)	6.4 (43)	6.6 (52)	6.4 (345)	6.1 (193)	6.5 (919)
5	5/11 - 5/17	5.9 (427)	5.6 (144)	5.7 (204)	6.2 (126)	5.5 (315)	5.8 (1216)
6	5/18 - 5/24	4.9 (288)	4.8 (181)	4.9 (210)	4.9 (170)	4.7 (219)	4.8 (912)
7	5/25 - 5/31	4.1 (130)	4.1 (78)	4.0 (228)	n.a. (1)	3.7 (170)	4.0 (607)
8	6/1 - 6/15	n.a. (1)		4.2 (30)		n.a. (1)	4.3 (32)
Total		5.8 (1219)	5.1 (461)	4.9 (727)	6.3 (918)	5.2 (963)	5.5 (4288)

Note: average travel time not shown for samples of less than 10 fish.

TABLE 40. Average travel time from McNary Dam to Bonneville Dam in 1999 for combined PIT tagged fish release from traps on the Salmon, Snake, Imnaha, and Grande Ronde rivers, grouped by passage period at McNary Dam.

		Average travel time (days)		Number of fish	
Block	McNary Date range	Steelhead		Steelhead	
		Hatchery	Wild	Hatchery	Wild
1	4/16 - 5/4	7.1	5.7	40	19
2	5/5 - 5/18	6.4	5.9	77	28
3	5/19 - 5/25	5.3	4.9	36	36
4	5/26 - 6/1	5.4	4.6	90	32
Block	McNary Date range	Chinook		Chinook	
		Hatchery	Wild	Hatchery	Wild
1	4/15 - 4/26	6.6	8.0	17	95
2	4/27 - 5/3	6.4	7.8	66	196
3	5/4 - 5/10	6.3	7.3	89	216
4	5/11 - 5/17	5.7	6.0	120	125
5	5/18 - 5/24	4.6	5.0	83	52
6	5/25 - 6/3	4.0	4.0	73	38

TABLE 41. Average travel time for Mid-Columbia River hatchery chinook from hatchery site to McNary Dam and from McNary Dam to Bonneville Dam in 1999, grouped by week of passage at McNary Dam.

Week	McNary Date range	Leavenworth Hatchery Chinook			Winthrop Hatchery Chinook		
		Number	Travel time (days)		Number	Travel time (days)	
			Site to McNary	McNary to Bonneville		Site to McNary	McNary to Bonneville
1	4/29 - 5/5	19	13.2	7.8	24	18.4	6.3
2	5/6 - 5/12	47	20.5	7.7	66	23.3	6.4
3	5/13 - 5/19	111	27.3	6.2	83	30.3	5.7
4	5/20 - 5/26	59	33.3	5.1	21	35.9	4.9

The average travel times for subyearling chinook of Mid-Columbia River basin origin are presented in Table 42. The average travel time from McNary Dam to Bonneville Dam averaged 7 to 9 days for hatchery fall chinook from Priest Rapids and Ringold hatcheries over the course of the summer time migration period, while Wells Hatchery summer chinook's average travel time was about 5 days. The longer migration distance to McNary Dam for Wells Hatchery smolts may contribute to this lower average travel time within the lower Columbia river reach. As for wild subyearling chinook collected, PIT tagged, and released at the Hanford reach, the higher average

TABLE 42. Average travel time for Mid-Columbia River basin wild and hatchery subyearling chinook from McNary Dam to Bonneville Dam in 1999, grouped by passage period at McNary Dam.

McNary Date range	Average travel time (days)											
	Hanford Reach Wild Chinook			Priest Rapids Hatchery			Ringold Hatchery			Wells Hatchery		
	No. of Fish	Site to MCN	MCN to BON	No. of Fish	Site to MCN	MCN to BON	No. of Fish	Site to MCN	MCN to BON	No. of Fish	Site to MCN	MCN to BON
6/19 - 7/3	18	21.7	14.0	59	8.6	7.8	45	9.2	8.7			
7/4 - 7/23	28	35.4	7.4	23	18.6	9.0	24	21.7	7.7	18	25.5	5.1

travel time for fish that pass McNary Dam earlier may be reflecting a longer rearing period in the McNary Dam to Bonneville Dam index reach than the later passing wild fall chinook smolts.

For smolts PIT tagged and released from Rock Island Dam, the average travel time in the McNary Dam to Bonneville Dam index reach was lowest (around 5 days) during the period of highest flows for yearling and subyearling chinook and sockeye (Table 43, Figure 38, and Figure 39). Hatchery and wild stocks are combined in all groups. Steelhead average travel times in the lower Columbia River reach remained low (also around 5 days) during both the early high flow period after April 24 and the later high flow period after May 26 (Table 43 and Figure 38). While migrating from Rock Island Dam to Bonneville Dam in 1999, the PIT tagged yearling and subyearling chinook, steelhead, and sockeye smolts spent on average similar amounts of time between McNary and Bonneville dams. However, from Rock Island to McNary Dam, the average travel time for sockeye and steelhead was about half of that for yearling and subyearling chinook (Table 43).

TABLE 43. Average travel time for PIT tagged chinook, steelhead, and sockeye released from Rock Island Dam to McNary Dam and between McNary and Bonneville dams in 1999, grouped by passage period at McNary Dam.

Species	Age	Block	McNary Date range	Number of Fish	Average travel time (days)	
					Rock Island Dam to McNary Dam	McNary Dam to Bonneville Dam
Chinook	0	1	6/29 - 7/21	17	13.0	4.9
Chinook	0	2	7/29 - 8/9	20	16.2	6.8
Chinook	1	1	4/26 - 5/9	42	11.1	7.0
Chinook	1	2	5/10 - 5/20	50	15.4	6.4
Chinook	1	3	5/21 - 6/2	31	12.8	4.5
Sockeye		1	4/28 - 5/8	30	6.9	8.2
Sockeye		2	5/9 - 5/15	28	9.6	6.7
Sockeye		3	5/16 - 5/29	26	6.4	5.3
Steelhead		1	4/26 - 5/9	29	6.3	4.8
Steelhead		2	5/10 - 5/20	45	6.5	5.9
Steelhead		3	5/21 - 6/2	26	7.5	5.1

4. Comparison of travel times in key index reaches for Snake River basin hatchery chinook

With the large numbers of PIT tagged yearling chinook being released from selected hatcheries above Lower Granite Dam, there was the possibility of measuring travel time for the same 265 fish through each major reach from the hatchery to Bonneville Dam in 1999. This allows us to approximate the time these hatchery chinook spent, on average, in each reach. Table 19 shows the average travel time for five hatchery stocks, partitioned into two temporal periods based on date of passage at Lower Granite Dam. Fish entering the hydro system after May 10 (second period) were exposed to higher flow conditions in the Snake and lower Columbia rivers than those fish entering the hydro system during the first period (refer to Figure 22). The fish passing through the hydro system in the later period had average travel times from Lower Granite Dam to Bonneville Dam that were approximately 75% lower than the average travel times of fish passing through the hydro system in the earlier period. However, the hatchery fish that entered the hydro system during the second block (after May 10) have spent, on average, about 15 days more to arrive at Lower Granite Dam (rough estimate, see footnote to (Table 44), so their overall duration of time to migrate to below Bonneville Dam was still longer. For each hatchery group in both the earlier and later passage periods, the average travel time was approximately twice as long in the Lower Granite to McNary Dam index reach (140 miles) than it was in McNary Dam to Bonneville Dam index reach (147 miles). Likewise, even for hatchery groups in the earlier passage period, it took over twice as long, on average, to migrate from the hatchery to Lower Granite Dam than it took to migrate between Lower Granite and McNary dams. Distances from hatchery release site to Lower Granite Dam for the five hatcheries are: Dworshak 72 miles; Imnaha 130 miles; Lookingglass 148; Rapid River 176 miles; and McCall 284 miles. Although the distances to Lower Granite Dam vary greatly among the five hatcheries, the average travel times were fairly similar among hatcheries within the separate passage periods.

E. Estimates of Survival:

Survival is estimated from release to first detection site, and between series of dams, by the Jolly-Seber release-recapture method outlined in American Fisheries Society Monograph 5, *Design and analysis methods for fish survival experiments based on release-recapture*, by K.P. Burnham, D.R. Anderson, G.C. White, C. Brownie, and K.H. Pollock, 1987. For a specified group of fish, this methodology provides a group estimate of survival through a series of reservoirs and dams, as well as a group estimate of collection efficiency at the dams. For the group of PIT tagged fish of interest, this method uses the subsequent detection information on the known number of fish re-released at a particular dam to estimate the number of fish that past that particular dam alive but undetected. By adding the number of fish detected at the dam and the estimated number of fish alive but undetected passing the dam, we have an estimate of the total number of fish from the group of interest at that particular site. Dividing that estimated total by the estimated

TABLE 44. Average travel time for Snake River basin hatchery chinook in 1999 from release site to Lower Granite Dam, Lower Granite Dam to McNary Dam, and McNary Dam to Bonneville Dam for group of PIT tagged fish present in each reach of interest.

Hatchery	Block	Lower Granite Date range	Number of Fish	Average travel time		
				Site[1] to Lower Granite Dam	Lower Granite to McNary Dam	McNary to Bonneville Dam
Dworshak	1	4/18 - 5/10	31	23.2	11.4	6.0
Dworshak	2	5/11 - 5/27	4	38.5	8.6	3.9
Imnaha	1	4/18 - 5/10	32	32.3	11.2	5.4
Imnaha	2	5/11 - 5/27	17	44.3	9.2	3.9
McCall	1	4/18 - 5/10	19	27.6	10.9	5.4
McCall	2	5/11 - 5/27	20	43.2	7.9	4.2
Lookingglass	1	4/18 - 5/10	65	26.4	10.9	6.4
Rapid River	1	4/18 - 5/10	54	29.5	10.7	5.4
Rapid River	2	5/11 - 5/27	23	46.5	7.4	3.8

[1] Release dates reported in PTAGIS database for each hatchery differs in its level of accuracy for individual fish since some releases are volitional from ponds over a month, while other releases are known to the day or within a short range of days. Specifics are: Dworshak – known to the day for raceway releases; McCall – known to within the four-day trucking period for fish released from common ponds; Imnaha – known to actual date for small group held and released on April 5, but most fish have first day of volitional one-month period reported (the above travel times estimates assume median emigration occurred 15 days later at the midpoint of the release period); Lookingglass – all fish have first day of volitional one-month release period reported (the above travel times estimates assume median emigration occurred 15 days later at the midpoint of the release period); and Rapid River – all fish have the hatchery managers's projected date of median emigration from the ponds reported.

total of an upstream dam, we arrived at the survival estimate from the tailrace of the upstream dam to the tailrace of the downstream dam. If one divides by the release number, then an estimate of survival from release to the tailrace of the downstream dam of interest is obtained.

In 1999, a total of 55 groups of wild and hatchery chinook and steelhead were created for survival estimation from the daily releases of PIT tagged fish from the four traps above Lower Granite Dam. The weekly tagging goal for survival estimation was set at 600 fish, but this number of fish per week was not always possible. Release period durations often extended longer than one week to try to achieve the target release size. Thirty groups spanned 4 to 7 days, 22 groups spanned 8 to 12 days, and 3 groups spanned 16 to 19 days. Of the 55 groups created, there are 4 groups with 250-499 fish, 26 groups with 500-699 fish, and 25 groups with over 700 fish. The detailed survival tables for these 55 groups are presented in Appendix G and summarized in the text below. The format of the data in this appendix is identical to that found in prior FPC Annual Reports, showing survival from release site to Lower Monumental Dam tailrace and for the three shorter reaches that make up this longer reach. The extended multi-dam reach survival estimate is the product of three shorter reach estimates. The associated variance for the extended reach estimate is computed using Meyer's (1975) formulas for propagation of error in products of non-independent estimates. For each release location, species, rearing type of fish (hatchery or wild), and release period, we obtain an extended reach survival estimate with associated 95% confidence interval.

Reach survival from Rock Island Dam to McNary Dam in 1999 was estimated for a total of 11 groups of wild and hatchery chinook, steelhead, and sockeye released from Rock Island Dam. Because of fewer detection sites for mid-Columbia released fish, the release period durations were extended to obtain at least 1200 fish per group. Release period durations ranging from 8 to 19 days (except for one 26 day period) produced release sample sizes ranging from 1209 to 1615 fish. The estimated survival to McNary Dam tailrace for the 11 groups released from Rock Island Dam are presented in Appendix G and summarized in the text below.

Survival estimates were also obtained for hatchery yearling chinook and steelhead from five hatcheries in the Snake River drainage, hatchery yearling and subyearling chinook from three hatcheries in the Mid-Columbia River drainage, and wild subyearling chinook from the Hanford reach. Data for the Snake River hatcheries show survival estimates from release site to Lower Monumental Dam tailrace (product of three reach survival estimates) and from release site to John Day Dam tailrace (product of five reach survival estimates). Data from the Mid-Columbia River hatcheries show survival estimates from release site to McNary Dam only. Data for these reaches are presented in Appendix G and summarized in the text below.

For each species and rearing type, a seasonal average was obtained for releases from the four traps and Rock Island Dam whenever the survival estimates of the groups released over time did not significantly differ. To determine any significant differences occurred within a year, a test of whether the "between group" variance component was significantly greater than zero (Burnham 1987 *et al*., Chapter 4). This is a chi-square test equal to [empirical variance of mean survival*(1-degrees of freedom)]/ [theoretical variance of mean survival]. In cases where the chi-square test was not significant at the 95% confidence level, then the average was computed for the season, along with the average theoretical variance. In cases where the chi-square test was significant, then the season was split into periods showing the different survival levels.

The 1999 seasonal estimate of survival for PIT tagged hatchery chinook from the four trap sites to Lower Monumental Dam tailrace averaged between 58.0% and 70.6% for the fish released from the tributary traps on the Salmon, Imnaha, and Grande Ronde rivers (Table 45). It appears that much of the early mortality occurring with hatchery chinook after initial release from facilities was completed prior to passing Lewiston Idaho. Survival of run-at-large hatchery chinook collected, PIT tagged and released from the Snake River trap averaged 87.2% to the tailrace of Lower Monumental Dam. The Snake River trap released yearling chinook had significantly higher survival than the hatchery chinook from the other upstream trap locations based on non-overlapping confidence intervals. Wild chinook PIT tagged and released from the Salmon, Imnaha, and Grande Ronde rivers had average survival from release site to Lower Monumental Dam tailrace ranging between 80.6% and 82.5%, higher than their hatchery counterparts (Table 45). Survival of run-at-large wild chinook collected, PIT tagged and released from the Snake River trap averaged 86.5% to the tailrace of Lower Monumental Dam, which was virtually the same as obtained for their hatchery counterparts. Although not significantly different between years, the average of 1999 reach survival estimates were generally higher than in 1998 for both hatchery and wild chinook (Table 45).

TABLE 45. Yearling chinook annual reach survival estimate from release location at trap to tailrace of Lower Monumental Dam, 1999 compared to 1998.

Tag Site	Species	Rearing type	Year	Date Range	No. blocks averaged	Survival	Lower Limit	Upper Limit
Salmon R trap								
	Chinook	Wild	1998	3/23-5/1	3	0.777	0.697	0.857
			1999	3/18-4/30	5	0.809	0.775	0.844
Salmon R trap								
	Chinook	Hatchery	1998	4/6-5/1	3	0.679	0.618	0.740
			1999	3/18-5/21	8	0.694	0.660	0.729
Snake R trap								
	Chinook	Wild	1998	3/25-5/8	2	0.767	0.669	0.865
			1999	3/22-5/25	5	0.861	0.832	0.891
Snake R trap								
	Chinook	Hatchery	1998	4/13-5/8	4	0.797	0.729	0.865
			1999	4/5-5/25	5	0.884	0.842	0.926
Imnaha R trap								
	Chinook	Wild	1998	3/16-4/23	6	0.751	0.707	0.795
			1999	3/28-5/14	5	0.806	0.775	0.837
Imnaha R trap								
	Chinook	Hatchery	1998*	4/8-4/9	1	0.583	0.512	0.655
			1998*	4/13-4/14	1	0.738	0.624	0.853
			1999	4/4-4/16	2	0.610	0.554	0.665
Grande Ronde								
	Chinook	Wild	1998	3/24-5/8	2	0.699	0.600	0.798
			1999	4/12-4/30	1	0.825	0.756	0.894
Grande Ronde								
	Chinook	Hatchery	1998	4/8-4/9	1	0.776	0.619	0.934
			1999*	3/17-3/26	1	0.580	0.523	0.637
			1999*	3/29-4/9	1	0.706	0.634	0.779

*identifies a year with a significant “between blocks (temporal releases)” variance component. For those years, survival estimates are presented separately for each set of blocks that differ significantly.

The 1999 seasonal estimate of survival for PIT tagged hatchery steelhead from the three tributary traps to Lower Monumental Dam tailrace averaged between 69.2% and 72.0%. The estimates for PIT tagged wild steelhead averaged 81.8% for Snake River trap releases, 78.4% for Imnaha River trap releases, and 80.6% for Grande Ronde River trap releases (not enough Salmon River trap wild steelhead PIT tagged) (Table 46). Survival from the Snake River trap to Lower Monumental Dam tailrace averaged 84.9% for hatchery steelhead tagged and released in the later half of April and dropped to an average of 72.3% for fish tagged and released in May relative to 1998, the 1999 seasonal survival estimates for hatchery steelhead were not consistently higher or lower than in 1998.

TABLE 46. Steelhead annual reach survival estimate from release location at trap to tailrace of Lower Monumental Dam in 1999 (compared to 1998 for hatchery steelhead only).

Tag Site	Species	Rearing type	Year	Date Range	No. blocks averaged	Survival	Lower Limit	Upper Limit
Salmon R trap								
	Steelhead	Hatchery	1998	4/20-5/1	2	0.814	0.723	0.905
			1999	4/14-5/21	4	0.692	0.651	0.733
Snake R trap								
	Steelhead	Wild	1999	4/19-5/25	2	0.816	0.739	0.893
Snake R trap								
	Steelhead	Hatchery	1998	4/6-5/23	7	0.728	0.683	0.773
			1999*	4/19-4/30	2	0.874	0.817	0.930
			1999*	5/3-5/25	2	0.717	0.676	0.758
Imnaha R trap								
	Steelhead	Wild	1999	5/10-5/20	2	0.784	0.733	0.835
Imnaha R trap								
	Steelhead	Hatchery	1998	4/27-5/22	4	0.635	0.589	0.681
			1999	4/11-6/24	5	0.711	0.680	0.742
Grande Ronde								
	Steelhead	Wild	1999	4/19-5/25	2	0.806	0.747	0.866
Grande Ronde								
	Steelhead	Hatchery	1998	4/24-5/15	4	0.632	0.586	0.678
			1999	4/19-5/25	3	0.720	0.678	0.761

*identifies a year with a significant "between blocks (temporal releases)" variance component. For those years, survival estimates are presented separately for each set of blocks that differ significantly.

Note: 1999 wild steelhead survival estimates are not compared with 1998 estimates because of potential biases in the 1998 wild steelhead data as discussed on pages 67-68 of the 1998 Fish Passage Center's Annual Report.

The 1999 estimates of survival for PIT tagged hatchery chinook from the hatchery release site to the tailrace of John Day Dam was approximately 55% for Dworshak Hatchery fish, 56% for Rapid River Hatchery fish, 48% for Imnaha Hatchery fish, 42% for Lookingglass Hatchery fish, and 54% for McCall Hatchery fish (Table 47). Although not significantly different from 1998 estimates, the 1999 reach survival estimates were higher than in 1998 for the hatchery chinook. As for steelhead released from Dworshak Hatchery, estimated survival was approximately

48% in 1999 to the tailrace of John Day Dam (Table 47). The hatchery steelhead reach survival estimate is very close to the 1998 estimate.

TABLE 47. Reach survival estimates for hatchery yearling chinook and steelhead from release site to John Day Dam tailrace, 1999 compared to 1998.

Tag Site	Species	Rearing type	Year	Date Range	Release Number	Survival	Lower Limit	Upper Limit
McCall SFH								
	Chinook	Hatchery	1998	3/30	47460	0.384	0.340	0.429
			1999	4/6	47802	0.548	0.495	0.602
Rapid River SFH								
	Chinook	Hatchery	1998	V:4/13	48357	0.459	0.404	0.513
			1999	V: 4/2	47802	0.571	0.528	0.614
Imnaha Accl. Pond								
	Chinook	Hatchery	1998	4/6	19169	0.440	0.378	0.503
			1999	V: 3/16	22656	0.484	0.432	0.535
Lookingglass SFH								
	Chinook	Hatchery	1998	4/6	43939	0.373	0.324	0.422
			1999	V: 3/15	44548	0.418	0.392	0.444
Dworshak NFH								
	Chinook	Hatchery	1998	3/25-3/26	47704	0.484	0.425	0.544
			1999	4/7-4/8	47840	0.560	0.527	0.593
Dworshak NFH								
	Steelhead	Hatchery	1998	4/27-4/30	1500	0.500	0.347	0.652
			1999	4/26-4/30	3715	0.481	0.408	0.554

Volitional Release (V) Periods:
Rapid River SFH --4/13/98 is projected date of median release from 1 month volitional release
Rapid River SFH -- 4/2/99 is projected date of median release from 1 month volitional release
Imnaha Accl Pond -- 3/16/99 is first day of 1 month volitional release
Lookingglass SFH -- 3/15/99 is first day of 1 month volitional release

The 1999 survival for PIT tagged hatchery yearling chinook released from Leavenworth and Winthrop hatcheries was estimated at 58.6% and 56.8%, respectively, to McNary Dam tailrace (Table 48). The Leavenworth Hatchery fish passed four dams and the Winthrop Hatchery fish passed six dams. The 1999 estimated survival was not significantly different from 1998 for both the Leavenworth and Winthrop Hatchery fish. Subyearling chinook from Wells Hatchery (passing five dams) had estimated survival of 37.3% to the tailrace of McNary Dam, which is not significantly different (although higher) than subyearling chinook released from Priest Rapids and Ringold hatcheries (passing one dam) had estimated survival of 75.7% and 83.5%, respectively, to

McNary Dam tailrace in 1999. Wild subyearling chinook collected and PIT tagged in the Hanford reach had estimated survival of 40.0% to McNary Dam tailrace. This significantly lower survival estimate for Hanford reach wild subyearling chinook compared to the Priest Rapids Hatchery and Ringold Hatchery fish may be due to longer rearing time of the wild subyearling chinook in the McNary pool.

TABLE 48. Survival estimates for mid-Columbia River basin yearling and subyearling chinook from release site to McNary Dam tailrace, 1999 compared to 1998.

Tag Site	Species	Rearing type	Year	Release Date Range	Survival	Lower Limit	Upper Limit
Winthrop NFH							
	Chinook	Hatchery	1998	4/14	0.608	0.478	0.739
			1999	4/15	0.568	0.527	0.609
Leavenworth NFH							
	Chinook	Hatchery	1998	4/20	0.546	0.491	0.602
			1999	4/19	0.586	0.550	0.622
Wells SFH							
	Chinook	Hatchery	1998	6/10	0.291	0.241	0.340
			1999	6/19	0.373	0.281	0.465
Priest Rapids SFH							
	Chinook	Hatchery	1999	6/14-6/23	0.757	0.679	0.836
Ringold SFH							
	Chinook	Hatchery	1999	6/16	0.835	0.740	0.929
Hanford Reach							
	Chinook	Wild	1999	6/3-6/10	0.400	0.351	0.448

The 1999 average estimates of survival from Rock Island Dam to McNary Dam tailrace (Table 49) was 75.0% for total yearling chinook (combination of hatchery and wild fish), 63.9% for total steelhead, 65.0% for early migrating sockeye, 45.6% for late migrating sockeye, and 54.9% for subyearling chinook. These estimate were not significantly different from last year's estimates, except in the case of late migrating sockeye. The late migrating sockeye run which consists more of Osoyoos stock than Wenatchee stock had a significantly lower estimate of survival in 1999 to McNary Dam tailrace from Rock Island Dam.

TABLE 49. Annual reach survival estimate from release at Rock Island Dam to McNary Dam tailrace, 1999 compared to 1998.

Tag Site	Species	Rearing type	Year	Date Range	No. blocks averaged	Survival	Lower Limit	Upper Limit
Rock Island Dam								
	Chinook	Combined	1998	4/19-6/2	6	0.712	0.555	0.868
	Age 1		1999	4/20-5/31	3	0.750	0.673	0.827
Rock Island Dam								
	Steelhead	Combined	1998	4/24-5/22	7	0.595	0.504	0.686
			1999	4/20-5/22	3	0.639	0.578	0.699
Rock Island Dam								
	Sockeye	Combined	1998	4/15-5/19	6	0.682	0.559	0.805
			1999*	4/20-5/3	1	0.650	0.561	0.739
			1999*	5/4-5/22	1	0.456	0.381	0.532
Rock Island Dam								
	Chinook	Combined	1998	6/24-7/21	5	0.616	0.541	0.690
	Age 0		1999	6/17-7/31	3	0.549	0.469	0.630

*identifies a year with a significant "between blocks (temporal releases)" variance component. For those years, survival estimates are presented separately for each set of blocks that differ significantly.

F. Conclusions:

- More fish passed Lower Granite Dam without being collected in 1999 compared to 1998 based on what was being observed at the next two dams downstream. Apparently a higher percentage of springtime migrants passed through spill this year at Lower Granite Dam.
- Hatchery subyearling chinook releases from two acclimation ponds above Lower Granite Dam introduced more summer migrants to the Snake River system in 1999.
- The 1999 smolt passage indices were higher at Rock Island Dam than in 1998.
- Annual cumulative passage index of subyearling chinook were higher at John Day Dam in 1999 than 1998 in spite of lower 1999 passage index at McNary Dam and lower hatchery production in the Umatilla River. A higher percentage of summertime migrants may have passed McNary Dam through spill in June of 1999 than in 1998.

Conclusions:

- The 1999 migration timing of yearling chinook, as referenced by the historic middle 80% passage dates, was similar at the start but extended later at Lower Granite Dam and curtailed sooner at Rock Island Dam.

- The 1999 migration timing of steelhead, as referenced by the historic middle 80% passage dates, was similar at the start and extended later at both Lower Granite and Rock Island dams for wild stocks. As for hatchery stocks, it started early at Lower Granite Dam and later at Rock Island Dam, but extended later at both dams.

- The greatest shift in migration timing was seen with subyearling chinook. The start was within 5-6 days of historic 10% date, but the dates of 90% passage was approximately two weeks later at McNary Dam and yet nearly 40 days earlier at John Day Dam. The higher flows in June and early July may have moved more subyearling chinook through John Day pool quicker in 1999 than the historic years.

- Average smolt travel times of yearling chinook and steelhead from Lower Granite Dam to McNary Dam were lowest during May 18 to May 31 for trap released fish, a period when flows increased to their highest springtime levels.

- When lower Columbia River flows increased to their highest levels after May 25, the travel time from McNary Dam to Bonneville Dam averaged four days for hatchery and wild chinook and closer to five days for hatchery and wild steelhead.

- The average travel time of subyearling chinook of mid-Columbia origin between McNary and Bonneville dams was within the five to nine day range, except for early arriving Hanford reach wild subyearling chinook which averaged 14 days.

- From Rock Island Dam to McNary Dam, the average travel time for sockeye and steelhead was about half of that for yearling a subyearling chinook.

- Estimated survival from the Snake River trap to the tailrace of Lower Monumental Dam in 1999 averaged 87.2% for hatchery chinook and 86.5% for wild chinook.

- Estimated survival from the tributary traps to Lower Monumental Dam tailrace averaged below 70.6% for hatchery chinook and greater than 80.6% for wild chinook.

- Estimated survival from the Snake River trap to the tailrace of Lower Monumental Dam in 1999 averaged 84.9% for early migrating hatchery steelhead, 81.8% for wild steelhead, and 72.3% for hatchery steelhead tagged and released in May.

- Estimated survival from Snake River basin hatcheries from release site to John Day Dam tail-race ranged from approximately 42-56% for hatchery chinook (five hatcheries) and 48% for hatchery steelhead (one hatchery).

- Estimated survival from mid-Columbia hatcheries release sites upriver of Rock Island Dam to tailrace of McNary Dam were approximately 57-59% for yearling chinook (two hatcheries) and 37% for subyearling chinook (one hatchery).

- Estimated survival from Rock Island Dam to McNary Dam tailrace in 1999 was approximately 75% for yearling chinook, 64% for steelhead, 65% for early migrating sockeye, 46% for late migrating (after May 3) sockeye, and 55% for subyearling chinook.

IV. Adult Fish Passage

A. Overview

Annually, adult salmon (all races and species) along with other species such as lamprey, shad and resident fishes are counted as they migrate upstream past mainstream Columbia and Snake River dams. These fish are either videotaped as they pass through the counting slots or are directly counted by personnel. Videotapes are later reviewed and counts tallied for the day. The length of the counting seasons as well as the number of hours counted per day is predetermined by the fishery agencies and contracting agencies. The U. S. Army Corps of Engineers (COE) contracts with the Washington Department of Fish and Wildlife to count fish at COE projects while the Public Utility Districts (PUD) contract personnel to count adult fish at their dams. Daily counts from each dam are reported to the COE and final data are compiled and incorporated in an annual Fish Passage Report by the COE. In addition, fish counts are now available on Web sites including the FPC Web site.

The Fish Passage Center reports on adult fish passage and passage conditions at the dams throughout the adult fish migration. The FPC Weekly Report incorporates adult fish counts for that season and compares that total to the previous year as well as the 10-year average through the same block of time. An annual report titled **Adult Fishway Inspections at the Mainstream Snake and Columbia River Dams** summarizes inspections made at the COE and PUD projects. The inspections are completed to assure that their fishways are maintained at acceptable criteria levels throughout the fish passage season. State and Federal fish agencies complete the fish facilities inspections.

Some general conditions that existed during the adult fish passage season that might have affected fish passage at the mainstream dams are listed.

- In a positive way, water temperatures were moderate during the summer and late fall in 1999 and should have improved passage conditions for fish passing through the Columbia and Snake rivers during the summer months.

- Spill levels were fairly high during the late spring and early summer and may have contributed to adult fallback at some projects. Fish were also examined for head burns and rated according to established protocol from early April through late July at Bonneville and Lower Granite dams. Signs of head burn on adult salmon were minimal for the season with less than 1% of the sampled fish affected at Bonneville Dam. This percentage increased at the Lower Granite trapping site to about 3% (information supplied to Fish Passage Center by CRITFC at Bonneville Dam and by NMFS at Lower Granite Dam).

- The COE and PUD should continue to take aggressive steps to upgrade fish facilities. Where possible, fishway control systems should be computerized and automated to allow better control of the main entrance gates, water flow through the channels and keep their fish passage facilities operating within acceptable criteria ranges.

B. Adult Fish Counts

1. Spring Chinook Salmon

In 1999, numbers of adult spring chinook salmon returning to Bonneville Dam and upstream sites remained at the same low levels as noted in 1998. The count of adult spring chinook salmon at Bonneville dam was 38,669; almost equal to the 1998 count, but only 58% of the 10-year average. Figure 40 illustrates the decline of adult spring chinook during the 1994, 95, and 96 seasons; the large increase in adult returns noted in 1997, and then the drop to less than 40,000 fish in 1998 and 1999. This year's adult run was comprised of a mixture of 4- and 5-year old fish that normally spend two or three years of their life cycle in the ocean. The sampling completed at the Bonneville trapping site utilizes length information and scale analysis for determining age of the fish. The Bonneville count of 8,691 jack chinook was the highest total since 1976 with the previous closest count occurring in 1985 when about 7,800 (3-year old fish) were counted.

Of the Bonneville count (38,669), only 45% or 17,563 passed The Dalles Dam this year. The Wind, Klickitat, Little and Big White Salmon, and Hood rivers all support spring chinook via hatchery programs or programs to establish "natural" runs in these Basins. Returns of adult spring chinook again allowed a small number of fish to be taken by the sport fishery and tribal ceremonial fishery in this Reach.

About 30.5% of the spring chinook counted at The Dalles Dam chose the Snake River. This percentage was well below the 1997 and 1998 percentages. Only 62% of the fish entering the Snake River were counted past Lower Granite Dam (3,296). Estimated **hatchery** chinook at Lower Granite Dam comprised a minimum of 60% of the run [note that this percentage is based only on the absence of the adipose fin]. The remainder [unclipped fish] are considered to be “wild” or “natural” fish. In some cases a poorly clipped fin or missed clipping of a fin can lead to the miss identification of a hatchery fish as a wild fish. The spring chinook count in the Snake River was about 30% of the 1997 count and 68% of the 10-year average. Overall, the return of adult spring chinook to the Snake River basin was extremely low (number wise); however, the count was higher than expected given the few juvenile fish that migrated to the ocean in 1997.

The number of “jack” spring chinook salmon that returned to the Snake River was 4.4 times greater than the 10-year average and 23 times greater than the 1998 count. These “jacks” were from the 1996 brood year and migrated in 1998. About 2,700 “jacks” were counted at Ice Harbor Dam with 2,500 continuing over Lower Granite Dam. This increase in the jack count is reason for optimism; the pre-season forecast made by the Technical Advisory Committee (TAC) is projecting a return of 58,000 Snake River fish to the Columbia River in 2000. This total should allow greater escapement of wild “threatened” spring/summer chinook to the Snake River Basin in 2000.

The spring chinook count at Priest Rapids Dam was 4,139 with 3,309 fish arriving at Rock Island Dam. The 1999 count was near equal the 1998 adult spring chinook count at both projects. However, the 1999 counts were only 42% and 45% of the 10-year average for spring chinook returning to Priest Rapids and Rock Island dams, respectively. Most spring chinook returning to the Mid-Columbia River are hatchery reared fish; however, not all hatchery spring chinook are fin clipped to signify being of hatchery origin and no hatchery/wild adult return estimates were made from the fish counts. Because of expected low return of adult spring chinook to the area above Wells Dam, initially, all spring chinook were trapped and held at Wells Hatchery or Methow Hatchery with distribution to Winthrop Hatchery as required. The actual return to Wells Dam was greater than anticipated and as such, trapping was reduced to 3-days per week and approximately 130 adult and jack chinook released from Wells and Methow hatcheries. Although numbers of spring chinook returning to the Mid-Columbia River remain at low levels, returns above Rock Island Dam were better than at first anticipated.

Spring chinook “jack” salmon count at Priest Rapids Dam was 761, about 21 times greater than the 1998 “jack” returns and five times greater than the 10-year average. Expected return of adult salmon to the upper Columbia River should rebound to about 28,000 in year 2000 based on TAC estimates.

2. Summer Chinook

The summer chinook count at Bonneville Dam was 26,169, about 5,000 greater than the previous year and 10-year average. The count of summer chinook at The Dalles Dam dropped to 21,730, about 82% of the Bonneville Dam count (Note: This percentage reduction was about 10% greater than the 1998 conversion between Bonneville and The Dalles dams).

The Snake River count at Ice Harbor Dam was 3,900 adult summer chinook or 18% of The Dalles count. The Lower Granite Dam count was 3,260 for the season, about 84% of the Ice Harbor count. The summer chinook count at Lower Granite was about 74.9% of the 1998 and 77.4% of the 10-year average. Based on clipped and unclipped adipose fins, the bulk of fish, about 53%, were not fin clipped. As in previous years, most summer chinook are destined for the South Fork of the Salmon River and its tributaries. The count of summer chinook “jacks” was also encouraging as 1,584 returned to Lower Granite Dam. This total was 4.8 and 3.7 times greater than the respective 1998 and 10-year average at the project. The 2000 forecast by TAC was not estimated but should show an overall increase based on “jack” salmon returns in 1999.

The Mid-Columbia count of adult summer chinook was 20,896, a total about 1.6 and 1.5 times greater than the respective 1998 and 10-year average. The passage of summer chinook at Rock Island Dam was 18,588 with 10,536 recorded at Rocky Reach Dam. Summer chinook destined for the Wenatchee River basin comprised about 44% of the Run with the remaining 56% passing upstream of Rocky Reach Dam. These percentages were similar to the 1998 totals. As in previous years, summer chinook can be either trapped at Wells Dam or else can volitionally enter Wells Hatchery for their hatchery program. One interesting point was that “jack” summer chinook counted at Priest Rapids Dam was about 1/3 the jack count at Rock Island Dam and 50% of the Rocky Reach count. Overall, this would suggest that fish counts were highly variable enumerating “jack chinook” for the summer chinook in the Mid-Columbia in 1999.

3. Fall Chinook

The number of fall chinook counted at Bonneville Dam was 242,143 with an additional 23,500 jack chinook also counted. The 1999 adult count exceeded both the 1998 and 10-year average, while the jack count was 82% and 76% of the respective 1998 and 10-year average. The number of adult fall chinook (Bright component) that arrived at McNary Dam was reduced to 78,356 adults (Figure 41), however, this total was greater than the 1998 and the 10-year average. Most fall chinook passing McNary Dam are “wild” origin and generally destined for the Hanford Reach to spawn. Tule fall chinook estimated from the fish counts at Bonneville Dam totaled 46,800 with 14,379 adult chinook arriving at Spring Creek NFH, located in the Bonneville Dam pool (Figure 42). The number of Tule jack chinook reduced from about 5,500 (near record) returning to Spring Creek NFH in 1998 to only 261 in 1999 (one of the lower jack return rates for the hatchery).

As noted above, upriver Bright fall chinook returned in greater numbers in 1999 than the previous season with the turnoff into the Snake River of 6,532 adult fall chinook and 3,489 “jack” salmon. The 1999 chinook adult count was 1.5 and 1.8 times greater, respectively than the 1998 and 10-year average at Ice Harbor Dam. Passage of adult fall chinook at Lower Granite Dam was also well above the 10-year average for adult and “jack” fall chinook for the 1999 season. This year’s adult and jack counts at Lower Granite were comprised of 52% and 74% hatchery origin returns respectively based on the fish being clipped versus non clipped. All indications point to a continued increase in the number of fall chinook returning to the Snake River in 2000 and near term years based on the number of adult fish returning in 1999 as well as the high number of jack chinook that returned this year.

4. Sockeye Salmon

The number of sockeye salmon returning to Bonneville Dam was 17,875 for the season. The bulk of sockeye in the Columbia River are destined for the Mid-Columbia River with the 1999 returns of 4,200 Wenatchee stock and 13,700 Okanogan stock comprising the Run. The 1999 return was the 4th lowest on record and well below the 10-year average. The TAC is projecting a return of 31,200 for year 2000.

Sockeye salmon recovery efforts in the upper Salmon basin continued with captive brood stock, habitat and other enhancement efforts in Red Fish, Alturas, and Pettit Lakes to jump-start the survival of these endangered sockeye. In 1999, 23 sockeye (using video count - 24h/day) were counted at Lower Granite Dam and seven returned to Red Fish Lake. These returns were basically 1-ocean fish that would normally comprise a small portion of a brood year. Looking ahead, the large release of hatchery raised sockeye in spring 1998 should lead to potential greater numbers of adult sockeye returning in year 2000. The TAC estimated that the Snake River sockeye return would be 168, and this would be the highest Snake River run since 1983 if that occurred.

5. Coho Salmon

The combined return of adult and jack count of coho salmon was about 45,000, slightly below the 1998 return, but well above the 10-year average at Bonneville Dam. The 1999 count of coho was again fairly strong, due in part to release of more juvenile fish into river basins above Bonneville Dam. Coho production appears well established in the Yakama and Umatilla rivers. The majority of coho passing Bonneville Dam still "home" into rivers and hatcheries located in the Bonneville pool. About 12,000 **adult** coho were counted at John Day Dam with these fish normally destined for either the Umatilla River or the Yakama River. About 4,700 adult coho passed McNary Dam with most expected to enter the Yakama River. A total of 241 adult coho were counted at Lower Granite Dam in the Snake River basin. The count of adult coho at Wells Dam was 199 and was near equal to those in the Snake River.

6. Steelhead

The count of steelhead at Bonneville Dam totaled 206,488 and was approximately 112% and 91% of the respective 1998 and 10-year average. The count at The Dalles Dam was nearly 156,900 while John Day reported 165,300. In last year's FPC Report, the John Day steelhead counts were greater than The Dalles Dam as well. Obviously these numbers indicate a large discrepancy in steelhead counts in the lower river. It would appear that the counts at John Day are inflated. The reasons for the discrepancy have not yet been determined, but the COE and WDFW are assessing this problem. The number of steelhead counted at McNary Dam was 84,088, about 84% and 66% of the respective 1998 and 10-year average.

The count at Ice Harbor Dam was about 80,000 for 1999; Lower Granite reported about 74,450 for 1999. The Snake River steelhead count at Lower Granite Dam was about 104% and 88% of the respective 1998 and 10-year average. Adult returns of steelhead to the Snake River are comprised mainly of hatchery-reared fish and support a sport fishery while the "wild" steelhead remain depressed and are listed as "Threatened" under the ESA.

The Mid-Columbia count at Priest Rapids Dam was near 8,300, 142% and 96%, of the respective 1998 and 10-year average. This year's count of steelhead increased back up to the 1997 and 10-year average. About 6,400 steelhead were counted at Rock Island with 3,557 above Wells Dam. Returns of "wild" steelhead and Wells and Wenatchee stock hatchery steelhead in the upper Mid-Columbia River remain depressed and have been listed as "Threatened" under the ESA.

TABLE 50. 1999 Adult Year to Date Totals

	Spring Chinook						Summer Chinook					
	1999		1998		10-Yr Avg.		1999		1998		10-Yr Avg.	
DAM	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack	Adult	Jack
BON	38,669	8,691	38,342	775	66,606	2,467	26,169	4,022	21,433	2,678	20,784	2,653
TDA	17,563	6,180	25,225	518	39,635	1,617	21,730	3,207	15,462	1,444	17,039	1,868
JDA	15,409	5,089	21,820	378	31,309	1,325	22,210	2,504	16,246	1,534	15,357	1,707
MCN	9,260	3,972	19,415	337	30,860	1,525	19,275	2,343	16,226	1,408	16,460	1,733
IHR	5,351	2,657	12,434	130	16,094	620	3,900	1,311	5,473	304	4,420	406
LMN	3,924	2,726	10,598	131	15,276	682	3,372	1,344	4,290	301	4,196	434
LGS	3,445	2,690	10,512	118	*	*	3,273	1,583	4,298	334	*	*
LWG	3,296	2,507	9,854	109	13,146	573	3,260	1,584	4,355	328	4,213	426
PRD	4,139	761	4,124	37	9,804	151	20,896	517	13,387	601	13,946	595
RIS	3,309	915	3,187	54	7,271	160	18,588	1,548	11,689	1,165	11,682	933
RRH	1,389	233	762	54	1,670	39	10,536	1,140	6,706	326	4,603	383
WEL	141	199	6	24	902	41	7,335	541	3,237	733	2,825	322

	Fall Chinook					
	1999		1998		10-Yr Avg.	
DAM	Adult	Jack	Adult	Jack	Adult	Jack
BON	242,143	23,482	189,085	28,631	178,117	30,735
TDA	131,786	19,025	92,932	18,551	103,153	21,170
JDA	106,052	12,018	78,237	11,834	77,832	16,188
MCN	78,356	8,740	63,791	13,427	66,647	17,995
IHR	6,532	3,489	4,220	3,491	3,569	1,562
LMN	5,508	3,397	3,046	3,171	2,226	1,190
LGS	4,196	2,048	2,032	2,504	*	*
LWG	3,384	1,863	1,909	2,002	1,027	449
PRD	29,537	1,191	9,662	1,604	9,570	2,180
RIS	7,590	847	3,848	945	4,314	1,747
RRH	5,492	4,090	2,824	412	2,817	725
WEL	1,925	631	1,047	158	1,017	270

TABLE 50. 1999 Adult Year to Date Totals
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	Coho						Sockeye			Steelhead			
	1999		1998		10-Yr Avg.				10-Yr			10-Yr	Wild
DAM	Adult	Jack	Adult	Jack	Adult	Jack	1999	1998	Avg.	1999	1998	Avg.	1999
BON	40,684	4,468	46,290	3,630	24,126	4,888	17,875	13,218	44,504	206,488	185,094	226,182	55,064
TDA	13,393	1,648	8,196	775	4,760	1,326	13,715	8,828	35,479	156,874	116,682	162,040	41,379
JDA	11,901	1,331	7,646	851	3,735	1,109	14,809	9,837	36,723	165,314	158,567	143,988	41,316
MCN	4,736	199	5,959	214	1,790	544	11,794	9,391	38,700	84,088	99,705	128,558	17,711
IHR	120	6	11	4	14	0	8	7	9	80,267	77,644	98,925	13,215
LMN	81	7	0	0	3	2	15	2	7	72,817	66,118	85,850	10,925
LGS	85	4	1	0	*	*	16	5	*	65,471	63,753	*	9,816
LWG	241	19	10	2	9	1	14	2	6	74,440	72,017	85,044	11,781
PRD	52	4	30	0	14	1	16,360	10,769	43,386	8,276	5,837	8,597	0
RIS	12	0	0	0	62	0	18,371	9,334	37,877	6,360	4,962	7,439	1,743
RRH	1	0	0	0	34	0	14,111	5,682	18,761	4,815	4,442	5,071	679
WEL	199	21	0	0	11	1	12,228	4,669	17,592	3,557	2,668	3,964	600

These numbers were collected from the COE's Running Sums text files.
Wild steelhead numbers are included in the total.
*WEL - WDFW was trapping Spring Chinook on both fish ladders.
**Adult count records at Little Goose Dam have been maintained since 1991, visual counts were not conducted at Little Goose Dam between 1982 and 1990.
***PRD is not reporting Wild Steelhead numbers.
Bonneville and Lower Granite were doing video counts only until April 1, 1999. These counts were 8 hour daytime video counts.
Historic counts (pre-1996) were obtained from CRITFC and compiled by the FPC.
Historic counts 1997 to present were obtained from the Corps of Engineers.
No Video counts at Lower Granite Dam on 3/1/99 and 3/2/99.

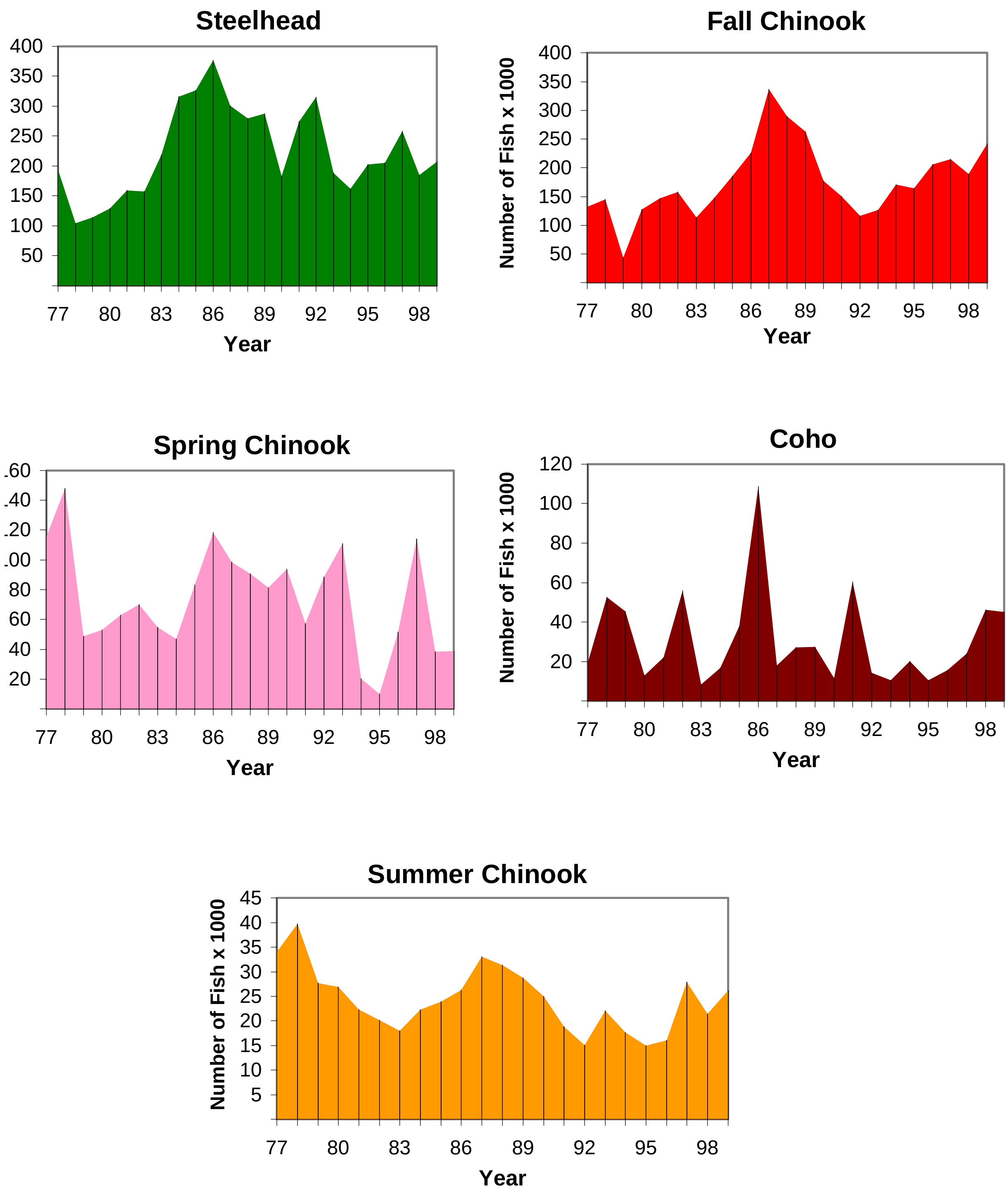

FIGURE 40. Adult Counts at Bonneville Dam, through 1999.

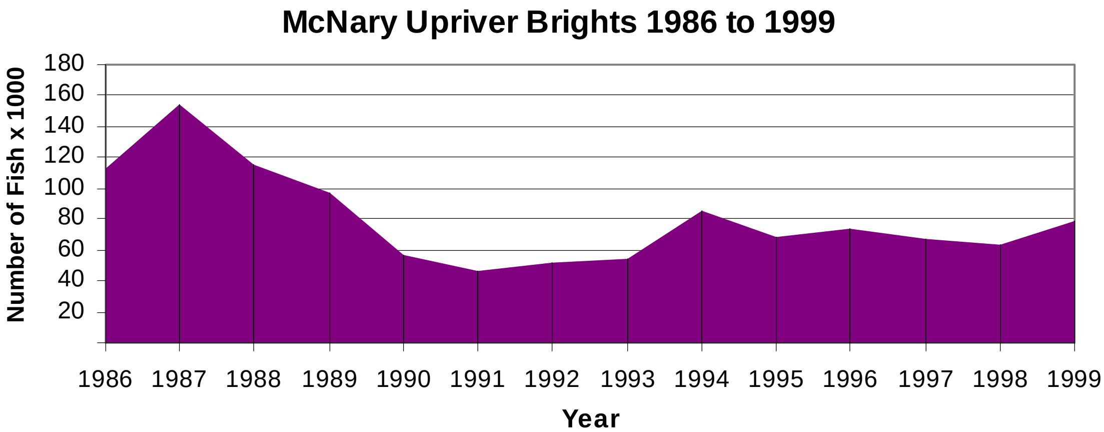

FIGURE 41. Upriver bright Fall Chinook passage at McNary Dam, 1986 to 1999.

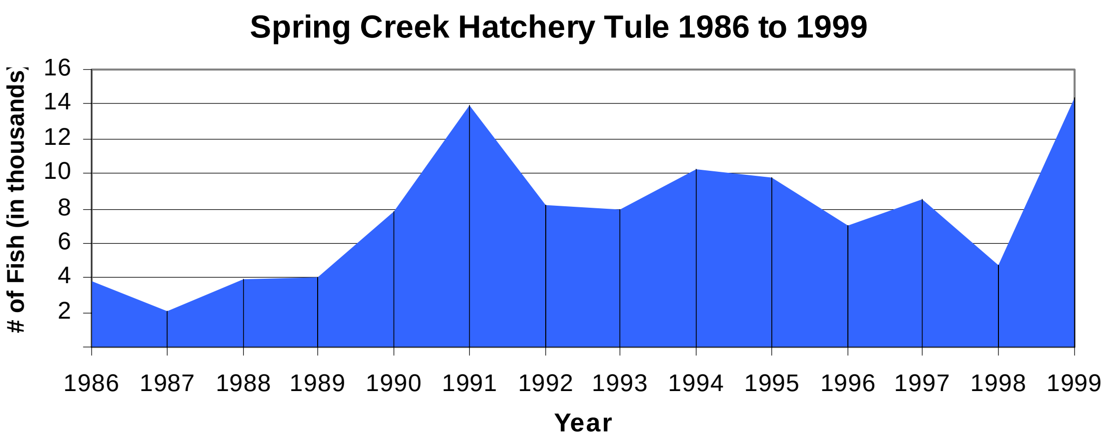

FIGURE 42. Tule Fall Chinook returns to Spring Creek Hatchery, 1986 to 1999.

V. Columbia River Basin Hatchery Releases

A. General Overview

The Fish Passage Center maintains a hatchery database of anadromous salmon species released from State, Federal, and Tribal hatcheries for the current year (1999) as well as in past years (from 1980 - 1998). The FPC received planned hatchery release schedules, then updated these projected releases with preliminary totals until the release numbers were “finalized” by the State, Federal, and Tribal fish agencies. These proposed hatchery releases were generally updated on a weekly basis to assure that the Salmon Managers would have accurate information relating to the migration of juvenile fish from Columbia River hatcheries **upstream** of Bonneville Dam.

The FPC hatchery release schedules do not include egg plants that were made into Columbia River streams. Fry plants (not fall chinook fry) were included in the release schedules but will usually be listed as migrating the following year. The fry release totals would not be calculated in the annual total for that year. Also fish that were determined to be non anadromous by the fish managers would not be included in the FPC hatchery release schedule (an example would be the summer steelhead planted in Lake Simtustus in the Deschutes River Basin; these fish do not migrate from the lake).

In 1999, about 79.3 million juvenile salmon (species) were released from Federal, State, Tribal or private hatcheries into the Columbia River Basin **above Bonneville Dam**. Table 51 gives hatchery release totals by River zone, **Snake River, Mid-Columbia, and Lower Columbia**. The 1999 hatchery release totals were reduced about 5% from the previous season.

TABLE 51. Summary of Hatchery Releases by Species and Release Area for 1999.

Species	Snake River	Mid-Columbia	Lower Columbia	Total
Spring Chinook	9,310,391	4,957,740	5,488,404	19,756,535
Summer Chinook	1,613,897	2,977,484	0	4,591,381
Fall Chinook “Brights”	1,834,739	11,870,000	8,630,734	22,335,473
Fall Chinook “Tules”	0	0	10,592,075	10,592,075
Coho	788,358	1,486,500	7,198,477	9,473,335
Sockeye	151,899	210,591	0	362,490
Steelhead	9,837,385	1,739,914	649,665	12,226,964
TOTAL	**23,536,669**	**23,242,229**	**32,559,355**	**79,338,253**

The 1999 Hatchery Release Schedule Appendix I lists the agency, hatchery, release numbers along with other pertinent data such as mark groups, number per pound, date of release, release site, and river zone. The Release Schedule can be accessed through our FPC Website. Table 51 through Table 54 list the hatchery release totals from 1980 through 1999 for the Snake, Mid-Columbia, and Lower Columbia rivers.

The main factors affecting the 1999 hatchery release numbers were:

1. The number of hatchery spring chinook released in 1999 increased by 6.5 million.

2. A factor that reduced the release total was primarily from the lesser number of fall chinook "Tules" that were planted from Spring Creek NFH, 10.6 million in 1999 versus 22.5 million released in 1998.

B. Lower Columbia River

The Lower Columbia River is designated as the Reach from above Bonneville Dam to McNary Dam. This Reach accounted for approximately 41% of the fish released above Bonneville Dam in 1999. This percentage was reduced from the previous two years. About 32.6 million fish were released from hatcheries or acclimation ponds in this Reach with nearly 59% or 19.2 million being yearling or subyearling Tule or Bright fall chinook stocks (Table 52).

About 10.6 million Tule fall chinook were released from Spring Creek NFH nearly 11.9 million less than in 1998. The Bonneville pool is the only area that Tule fall chinook are present above Bonneville Dam. Approximately 8.6 million up-river Bright fall chinook were released in the Klickitat, Little White Salmon, and Umatilla rivers. The Bright fall chinook releases were slightly less than the 1998 total, but these hatchery releases of Bright fall chinook have been fairly stable over the past few years. Yearling releases comprised a small portion (450,000) of the total release with the subyearling releases accounting for the remaining portion 8.2 million.

The total number of yearling and subyearling spring chinook released from Lower Columbia River hatcheries was 5.5 million, about 20% less than the 1998 release total. (Table 52). The 1999 spring chinook production was reduced from levels recorded in 1990-95 but well above the low levels seen in 1996 and 1997. The Lower Columbia hatcheries released less spring chinook than the Snake River but more than the Mid-Columbia Reach. Subyearling spring chinook were planted in the Big White Salmon Rearing ponds with another 40k subyearling spring chinook planted in the upper Klickitat River in June. The remainder of the spring chinook were yearling fish released in the Wind, Klickitat, Little White Salmon, Hood, Umatilla, and Deschutes rivers in late March to May time frame.

The number of coho salmon released in spring, 1999, in the lower Columbia Reach was about 7.2 million, a total that falls within the range of 6.3 to 8.1 million fish recorded since 1987. Hatchery reared coho were released in the Klickitat, Little White Salmon, and Umatilla rivers. Hatcheries located below Bonneville Dam supply a large portion of the coho planted in the Klickitat and Umatilla rivers. Both Type-S and Type-N coho have been planted above Bonneville Dam in recent years.

Juvenile steelhead released in this Reach are comprised of both summer and winter races, with The Dalles Dam being the upper boundary for the Winter race of steelhead. The number of steelhead (summer and winter races) released in 1999 was about 650,000, and was within the range recorded in this Reach since 1991 (570k to 700k). Winter steelhead production was 82,000 for 1999 as compared to 114,000 for the 1998 season. Winter steelhead were planted in Rock Creek, Hood River, and the Big White Salmon River. About 567,500 summer steelhead were stocked in the Klickitat, Big White Salmon, Hood, Deschutes, and Umatilla rivers. The John Day River remains a “wild” stream with no steelhead or chinook planted in the river. Also, the WDFW did not plant hatchery steelhead in the Wind River in 1998 or 1999, and this policy will continue in future years. Hatcheries located below Bonneville Dam, Skamania [WDFW], and Oak Springs [ODFW]) supplied Winter Run steelhead and some Summer Run steelhead planted in this Reach.

TABLE 52. Lower Columbia Hatchery releases, 1980-1999.

Year	Spring Chinook	Fall Chinook	Summer Steelhead	Winter Steelhead	Coho	Lower Columbia Reach Totals
1980	5,338,500	31,896,000	433,500		5,495,500	43,163,500
1981	5,014,000	35,936,500	609,500		4,075,500	45,635,500
1982	4,295,500	28,093,500	489,000	33,000	4,097,500	37,008,500
1983	4,635,000	34,141,500	631,000		4,306,500	43,714,000
1984	6,398,645	24,256,048	443,536	90,589	3,905,834	35,094,652
1985	6,344,905	20,804,201	728,282	10,008	2,162,846	30,050,242
1986	6,581,373	19,073,721	491,287	75,340	4,883,127	31,104,848
1987	5,383,500	18,081,000	380,000	24,000	8,092,000	31,960,500
1988	5,884,000	19,987,000	419,000	28,000	7,505,500	33,823,500
1989	6,031,894	24,716,262	494,250	28,659	6,401,762	37,672,827
1990	6,499,389	19,271,587	412,587	45,893	7,950,268	34,179,724
1991	6,621,577	27,157,783	493,188	68,434	7,381,693	41,722,675
1992	8,623,797	33,267,850	673,146	45,855	6,405,141	49,015,789
1993	7,489,804	30,818,999	583,305	93,901	7,816,353	46,802,362
1994	8,650,987	27,816,769	541,864	82,706	6,299,002	43,391,328
1995	6,183,305	24,858,274	497,101	90,064	6,712,604	38,341,354
1996	4,748,321	26,442,513	573,614	100,935	8,021,423	39,886,806
1997	4,094,907	23,233,638	558,357	108,106	6,763,470	34,758,478
1998	6,887,702	31,805,034	567,303	114,288	7,254,648	46,628,975
1999	5,488,404	19,222,809	567589	82,076	7,198,477	32,559,355

C. Mid-Columbia River

The Mid-Columbia Reach or Zone encompasses the area from above McNary Dam to Chief Joseph Dam. In 1999, approximately 23.2 million juvenile salmonids were released, an increase of 0.9 million from the 1998 total (Table 53). Most of the difference can be attributed to the increased number of juvenile spring chinook released in this Reach in 1999 (5.0 million released in 1999 compared to 3.3 million in 1998).

Production releases of juvenile fall chinook (up-river Bright stock) totaled 11.9 million similar to the previous season. The fall chinook totals have ranged between 11.9 to 12.4 million released per year since 1996. Subyearling fall chinook were again released from Priest Rapids Hatchery, (6.7 million) with the remainder planted in the Yakima River basin and in the main Columbia River from Ringold Hatchery. No yearling fall chinook were released in 1999. Hatchery fall chinook comprised about 51% of the total fish released in this Zone.

Approximately 3 million summer chinook salmon were released directly from hatcheries, acclimation ponds or into Mid-Columbia streams and tributaries located above Rock Island Dam. Most summer chinook were held in the hatcheries until yearling age (2 million) and migrated down the river during the spring season. The subyearling releases (almost 1.0 million) were released in June and migrated through the Mid and Lower Columbia River in June, July and August. Summer chinook were released in the Wenatchee River, Similkameen River, Methow River, the mainstem Columbia River below Wells Dam from Wells Hatchery and another mainstem release about three miles above Rocky Reach Dam from Turtle Rock Hatchery.

Spring chinook hatchery releases totaled almost 5.0 million, all yearling fish in 1999. These chinook were planted in the Methow, Entiat, and Wenatchee rivers and tributaries with Ringold Hatchery spring chinook released directly into the small stream exiting from the hatchery. The 5.0 million spring chinook released in 1999 fell within the normal range recorded between 1980 and 1995 (3.8 – 6.4 million). One change from previous years was the addition of hatchery spring chinook released from Acclimation facilities in the Yakama River (Easton Pond and Clark Flat). Between these two Yakama Tribal facilities, 387,938 yearling spring chinook were volitionally released between mid-March and June 1.

Coho salmon production was near 1.5 million released in this Reach with 1.0 million planted in the Yakima River Basin and another 0.5 million released in the Wenatchee River. Under the present release scenario, all coho released in this Reach are hauled from other hatcheries below Bonneville Dam to acclimation pond(s) and held for a specified time frame until liberated from the pond. The 1999 release total in the Mid-Columbia fell within the range of 1.1 to 1.7 million since 1996. The release in the Wenatchee River was from Leavenworth Hatchery with several new sites now in operation in the Yakama River Basin as well. All coho releases were part of the Yakama Tribal Program to reestablish coho in the Yakama and Wenatchee River Basins.

For the Mid-Columbia Reach, 210,591 yearling sockeye salmon were released for the 1999 Migration Year. From 1991–1998, the hatchery production ranged between 207,000 to 403,000 with the 1999 total falling at the lower end of this range for the Reach. About 197,000 yearling sockeye were released from the net pens located in Lake Wenatchee in the fall proceeding the year they migrate from the Lake. The release occurred in November 1998 for the 1997 Brood Year Wenatchee stock sockeye migrating in 1999. This group was 100% ad clipped with no CWTs in the release. The Osoyoos stock sockeye were reared to yearling age at Cassimer Bar

Hatchery and released in the Okanogan River, RM 0.5 on April 7. All Osoyoos stock sockeye from the hatchery were RV clipped.

Since 1992, hatchery production of juvenile steelhead has been about 1.4 million per year in this Reach. In 1999, the total was 1.7 million, an increase from the preceding years. The Okanogan, Methow, Entiat, and Wenatchee rivers and tributaries receive most of the production releases in this Reach with the remaining fish released from Ringold Hatchery into the main Columbia River. Since this Reach stretches to McNary Dam, juvenile steelhead initially reared in the Lyons Ferry ponds and then transferred to the Dayton Acclimation facility (Touchet River) or directly released into the Walla Walla River are included in the Mid-Columbia River totals. About 300,000 steelhead were released into the Walla Walla River basin with the remainder from the upstream hatcheries in the Mid-Columbia River. Hatchery steelhead (Wells stock) are now on the Threatened List under the ESA.

TABLE 53. Mid-Columbia Hatchery releases, 1980-1999.

Year	Spring Chinook	Summer Chinook	Fall Chinook	Summer Steelhead	Coho	Sockeye	Mid-Columbia Reach Totals
1980	4,788,00	2,638,000	3,327,500	873,000	353,000		11,979,500
1981	5,161,00	2,271,500	5,115,500	848,000	1,089,500		14,485,500
1982	5,186,50	2,981,000	6,297,500	974,500	482,500		15,922,000
1983	4,369,00	1,609,000	10,276,500	1,471,500	536,000		18,262,000
1984	6,129,74	1,240,865	15,548,324	1,422,329	517,100		24,858,362
1985	4,715,72	1,630,322	10,689,637	1,344,712	388,790		18,769,190
1986	4,336,04	1,992,057	10,385,476	1,494,630	554,563		18,762,773
1987	4,535,00	1,413,000	8,583,500	1,740,200	911,500		17,183,200
1988	5,542,00	2,144,500	9,769,500	2,117,000	1,329,500		20,902,500
1989	4,508,51	2,597,099	7,571,364	1,751,287	1,084,753	107,299	17,620,319
1990	5,292,56	1,912,708	9,338,978	1,822,491	1,118,138	88,978	19,573,859
1991	6,455,02	2,258,293	7,185,575	1,913,905	1,125,130	355,638	19,293,570
1992	5,250,20	2,551,616	7,211,100	1,427,454	1,245,807	281,707	17,967,893
1993	4,171,28	1,800,199	8,857,582	1,368,682	1,167,694	354,595	17,720,038
1994	3,802,28	2,097,319	14,162,311	1,440,117	857,483	206,657	22,566,176
1995	5,076,89	270,748	14,399,490	1,414,719	666,862	231,406	24,550,121
1996	3,242,934	3,889,547	12,399,459	1,411,096	1,678,209	402,859	23,024,104
1997	1,328,676	3,403,136	12,407,097	1,420,394	1,124,821	399,158	20,083,282
1998	3,328,869	3,537,781	11,924,206	1,472,296	1,739,476	365,784	22,368,412
1999	4,957,740	2,977,484	11,870,000	1,739,914	1,486,500	210,591	23,242,229

D. Snake River

The total release of all species of salmon in the Snake River basin was 23.5 million for the 1999 migration season, an increase of 8.7 million from the previous year. In fact, the 1999 hatchery production releases were the 3rd highest on the FPC database since 1980 (Table 54).

The 1999 production release of hatchery spring chinook totaled 9.3 million, about 6.1 million greater than the 1998 release total. When compared to the low release numbers that were reported in the FPC database in 1980-83, 1993, and 1996-98, this year's release total was very high; however, most other years were close to the 1999 totals. Yearling spring chinook were released into the Clearwater, Grande Ronde, Salmon, Tucannon, and Imnaha River basins from hatcheries, acclimation ponds, or direct stream releases during the fall (mainly Clearwater River) and the spring season for the majority of the fish. **One change** noted for the 1999 groups was the release of some supplemental groups that were not adipose clipped as in previous years, rather they were marked only with CWTs. This has and will pose some problems in relating whether the fish are "Wild" or "Hatchery" at sampling sites, counting facilities or other locations in the fish's journey. This same practice was also used on supplementation groups of summer chinook released in the S. Fk. Salmon River.

During 1999, 1,613,897 juvenile summer chinook were released from McCall and Pahsimeroi hatcheries, an increase of about 1,000,000 above the 1998 total. The 1999 release was the 6th highest on record since McCall Hatchery came on line in 1981. Only a portion of the hatchery summer chinook from McCall Hatchery is listed as Threatened under the ESA. The Snake River summer chinook are similar to the spring chinook in that Basin with the fish reared to yearling-age prior to migrating to the ocean in mid-late April through early June.

Hatchery production of Snake River fall chinook appears to be on the upswing with 1.8 million released in 1999, about 1 million greater than in 1998. About 960,000 yearling chinook were released from Lyons Ferry Hatchery and acclimation facilities at Pittsburg Landing and CPT Johns on the Snake River and Big Canyon Creek on the Clearwater River. Subyearling fall chinook were released directly from Lyons Ferry Hatchery (204k) with 670,000 chinook released from the Cpt Johns and Big Canyon acclimation facilities. Yearling releases were completed in April with the subyearling chinook released in June. **One major change** was made regarding release of unmarked subyearling chinook at the acclimation sites. None of the 670k chinook received an adipose clip. Because of this, distinguishing "Hatchery from Wild" chinook was not totally possible as juvenile migrants, and will continue to be difficult to ascertain when these fish return as adults in future years.

The 1999 releases of sockeye into Red Fish, Alturas, and Pettit lakes and Red Fish Lake Creek and from Sawtooth Hatchery totaled 151,899. These releases occurred during the previous summer and fall (1998) into the lakes with only a single direct stream plant of 10,000 into Red Fish Lake Creek during April 1999. All sockeye were 100% marked with adipose fin clips. A small number of the fish were PIT tagged as well. The 1999 releases were the 2nd highest on our limited database starting in 1995. Numerous efforts are being taken to allow the sockeye to establish a natural spawning base in the Lake system to complement the hatchery reared fish released as juvenile migrants each year.

Coho salmon were again released in the Snake River basin in 1999. About 788,000 yearling coho from lower river hatcheries were planted into the Clearwater River making this release the highest of the three years coho were planted in the Snake River as part of the Nez Perce Program to reintroduce coho to the Snake River Basin. From the early releases, adult salmon are now returning to the Lower Granite Dam trap site as well as upstream areas.

Production of hatchery steelhead in the Snake River basin was near 9.8 million. Since 1988, steelhead production has ranged between 9.0 to 11.3 million with the 1999 production falling within this range. About 38.5% of the anadromous salmonids released from Snake River basin hatcheries were steelhead. B-Run steelhead were released in the Clearwater system and selected areas in the Salmon River Basin, and A-Run steelhead in the Salmon, Grande Ronde, Imnaha, and Tucannon River Basins, and other tributaries of the Snake River. Most steelhead are released during the spring, late March through late-May and migrate through the River in April and May with the stragglers in June.

TABLE 54. Snake River Hatchery releases, 1980-1999.

Year	Spring Chinook	Summer Chinook	Fall Chinook	Sockeye	Coho	Summer Steelhead	Snake River Reach Totals
1980	4,176,000					6,328,000	10,504,000
1981	3,492,500	249,500				4,624,000	8,366,000
1982	2,319,000	264,000				4,638,000	7,221,000
1983	5,393,500	197,500	79,000			4,310,500	9,980,500
1984	7,076,708	356,673	427,191			6,122,220	13,982,792
1985	7,086,889	781,405	1,317,921			5,849,153	15,035,368
1986	5,408,335	982,443	2,271,520			7,586,945	16,249,243
1987	10,120,90	1,217,000	1,060,500			7,717,200	20,115,600
1988	9,812,000	1,659,000	4,981,000			11,388,25	27,840,252
1989	9,632,161	1,991,300	2,153,882			9,008,783	22,786,126
1990	10,543,01	2,090,500	3,480,110			11,115,88	27,229,514
1991	8,806,172	936,100	224,660			11,330,84	21,297,776
1992	9,516,871	1,507,400	689,601			9,754,415	21,468,287
1993	4,633,546	982,300	966,793			10,302,37	16,885,016
1994	7,001,383	1,190,673	603,661			9,591,581	18,387,298
1995	9,863,821	2,331,477	374,882	45,092		9,755,153	22,370,425
1996	1,471,673	676,894	630,612	76,027	618,000	10,461,98	13,935,192
1997	484,014	360,678	1,137,678	1,926		9,951,088	11,935,384
1998	3,176,804	577,618	829,574	263,307	695,716	9,209,992	14,753,011
1999	9,310,391	1,613,897	1,834,739	151,899	788,358	9,837,385	23,536,669

APPENDIX A

Individual Reservoir Operations

A. Canadian Reservoir operations

Coordination of the Pacific Northwest and BC Hydro systems began in 1964 with the ratification of the Columbia River Treaty (Treaty). Under the Treaty, Canada was required to construct 15.5 MAF of storage at the Mica, Arrow and Duncan projects for optimum power generation and flood control downstream in Canada and the United States. The Treaty also allowed the US to construct the Libby project on the Kootenai River in Montana for flood control and other benefits. BC Hydro also built storage on the Columbia River system beyond what was required by the Treaty, termed Non-Treaty Storage (NTS). The Canadian storage projects are Mica, with 7 MAF of usable Treaty Storage and 5 MAF of Non-Treaty Storage, Arrow Lakes, with 7.1 MAF of Treaty Storage and 0.26 MAF of Non-Treaty Storage, and Duncan, with 1.4 MAF of Treaty Storage.

Non Treaty Storage Operations: The NTS agreement allows BC Hydro and BPA to augment or reduce Treaty flows on a daily basis to improve the coordination of the combined system. Non-Treaty transactions are zero-sum over time (i.e. in the long run, releases must equal storage transactions). There is an agreement between the federal parties and the Canadian party that during the storage period of May 1 through July 5, 1999; water may be stored into Mica Active storage space by BPA and/or BCH consistent with the Non-Treaty Storage Agreement. Stored water will be released during the return period, July 6 through August 31, 1998. The intent is to release all of the water stored by BPA and one-half of the water stored by BCH during the July/August period. However, water releases will not occur such that they cause spill at Mica or Revelstoke, or create flooding downstream of Arrow Dam.

Treaty Storage Operations: The Treaty requires Canada to operate at least 8.45 MAF of storage for flood control in Canada and the US. The U.S. downstream power benefits from Canadian Treaty storage are to be shared equally between the two countries. Each year the U.S. and Canadian Entities (BC Hydro, BPA and the COE) prepare an Assured Operating Plan with agreed Determinations of Downstream Power Benefits for the sixth succeeding year. Beginning with the 1997 through 1998 Assured Operating Plans, additional loads were included in June to assist meeting U.S. flow augmentation objectives. Each year a Detailed Operating Plan is prepared for the upcoming operating year that implements the Assured Operating Plan. Since 1993, the Entities have agreed only to mutual beneficial deviations from the Detailed Operating Plan, generally to meet U.S. salmon flow augmentation and Vernita Bar needs, in return for meeting Canadian trout and white fish spawning and for blowing dust on reservoir shorelines.

The coordinated system was operated for proportional draft in October and November 1998 at Proportional Draft Points of 2.4 and 1.7 respectively, as the inflows were lower than average. During the rest of the 1999 water year, the system was operated upon Energy Content Curve, except in December, when it was operated to Upper Rule Curve restrictions for flood control.

1. Mica Treaty Operations-Figure A-1

Fall/Winter Operations: Mica was operated for power generation and flood control as a part of the coordinated system during the October-March period. Mica January Final Runoff Volume Forecast was 101% of average and increased to 107% in the March Final.

Treaty elevations were decreasing from 2468.1 ft at the end of October, to 2402.7 ft at the end of March. Actual monthly average outflows (Treaty, Non Treaty and Flex) were in the range of 15 kcfs in February, to 29.98 kcfs in October.

Spring Operations: The reservoir was operated for flood control to Treaty elevation of 2394.1 ft by the end of April. Runoff Volume Forecasts in April and May were 106% of average and 107% of average, respectively. The reservoir started its annual refill cycle in May. Treaty elevation at the end of June was 2435.3 ft.

Summer Operations: The reservoir was refilled by the first half of August and then passing inflow through the end of September.

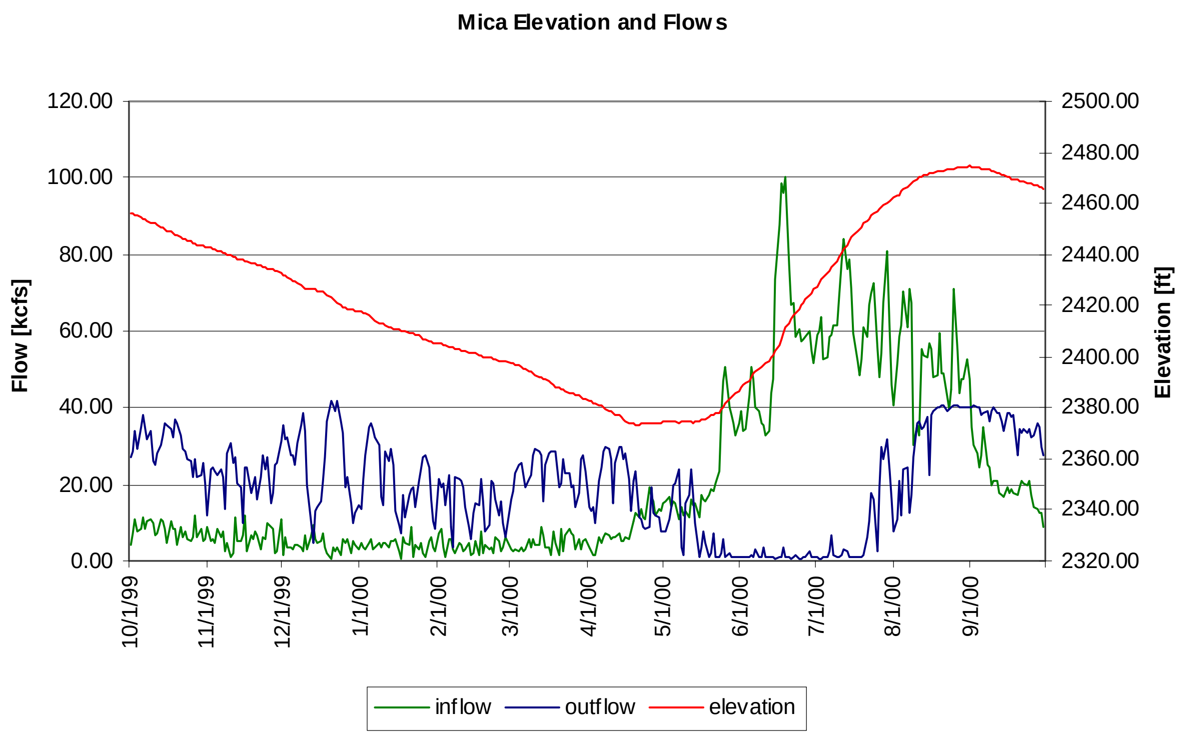

FIGURE A-1. 1999 Mica Operations

2. Mica Non-Treaty Operations

A summary of the Non Treaty Storage balances at the end of month for BPA and BC Hydro for the entire 1999 Water year is given in Table A-1.

TABLE A-1. End of Month Non-Treaty Storage Balances (Volume capacity of each storage is 1.1 MAF)

Months	BPA Account [ksfd]	BC Hydro Account [ksfd]
October	475.21	502.78
November	398.20	429.78
December	375.09	384.28
January	561.60	589.28
February	564.13	595.40
March	598.78	623.40
April	709.24	775.40
May	844.11	865.40
June	956.26	980.40
July	806.33	810.90
August	850.78	868.40
September	801.17	796.78

Both entities commenced the water year with Non-Treaty Storage less than half full. Both entities were equally releasing during the October-December period. The highest release was in October of 149 ksfd. The highest storage activity of about 200 ksfd was recorded in January at both entities. The reservoirs were refilling from January through the end of June period. The highest rates of refill were during the April-June period in the range of 107.6 ksfd to 152 ksfd for a month. Both entities, BPA and BC Hydro released 149.9 ksfd and 169.5 ksfd in July, at high rates in the range of 7.5 kcfs-20 kcfs during the last two weeks of July. As the inflows in Arrow were exceptionally high in August, 140% of average, and outflows below Arrow were very high, BPA and BC Hydro stored an additional 44.5 ksfd and 57.5 ksfd during the first half of August. BPA released 49.61 ksfd in September, and BC Hydro released 71.62 ksfd in September. Rates and dynamics of the September releases didn’t match the Salmon Managers request for flows in September for late fall chinook migration.

At the end of 1999 Water Year, about 800 ksfd remained in each account of both entities. The summary of the actual (Treaty, Non Treaty and Flex) monthly average outflows at Mica is given in Table A-2.

TABLE A-2. Mica Dam: Average Monthly Outflows

Month	**Monthly Average Flow at Mica [ksfc]**
October	29.98
November	22.22
December	26.04
January	21.23
February	15.00
March	23.25
April	18.53
May	7.65
June	1.21
July	7.45
August	32.22
September	36.12

Analysis of the 1999 monthly average flows at Mica and dynamics of the Non Treaty releases is showing that there was no coordination between BPA and BC Hydro releases to actually meet the flow target at McNary. Flows at McNary were below spring flow target in second and third week of May, when both entities were storing water at rates of 5 kcfs in NTS. Federal regulators decided to meet the minimum summer flow target at McNary, and that decision superseded the obligation of releases of the stored water in May-June period. Both entities stored water in August, as the flows were sufficiently high in the system and there was no power market at that time. Also, dynamics and rates of releases of NTS in September was not favorable for meeting the Salmon Managers request for late fall chinook migration flows at McNary.

3. Arrow Treaty Operations-Figure A-2.

Arrow reservoir is operated for non-power uses beside operations for system power generation and flood control as the part of the Treaty Operations. There are no power generation facilities at the project. Arrow implements special operations for salmon flow augmentation in the years when runoff volume forecast at The Dalles is less than 90 MAF, for whitefish spawning and incubation, for trout spawning, and the Vernita Bar agreement.

Fall/Winter Operations: The reservoir was operated for flood control and power generation during October 1998 through March 1999. The reservoir was operated to Upper Rule Curve restrictions in December for flood control, which is a higher order rule curve than Energy Content Curve. The end of December Treaty elevation was 1436.2 ft. The end of March Treaty elevation was 1377.9 ft. The major non-power requirement during the October-November period was the Vernita Bar agreement, which refers to a minimum stream flow objective for the Columbia River below Priest Rapids dam that is established each year to protect natural spawners during October through early May. This year it was determined that the minimum required flow was 65 kcfs for Vernita Bar. The operations agreement between the Canadian and US entities requires that the Grand Coulee project must be used to it’s maximum extent to provide Vernita Bar requirements before Treaty operations can be affected to protect Vernita Bar. Flows for whitefish were restricted to the range of 36 kcfs-41.7 kcfs during December 11-31 based on historical flows and low inflows for October-December period. Inflows were 58%, 70% and 79% of average for the October-December period respectively. After the January Runoff Volume Forecast was issued, showing 107% of average at Arrow, flows increased to 47 kcfs through January 17 and to 52 kcfs through January 27. Water, which was expected to be withheld during the whitefish operation, was predrafted in September 1998 by 150 ksfd, October 1998, 45 ksfd, November-December, 150 ksfd. Most of the water was returned in January, the first week of February (50 ksfd) and the first week of March (36 ksfd). The reservoir was drafted to its lowest elevation of 1377.9 ft in the February-March period for flood control. Flood control operations and high precipitation in area of 110% of average resulted in high outflows of 76.25 kcfs in February.

Spring Operations: The reservoir was refilling through the end of June to elevation of 1425.3 ft. The major non-power objective was to maintain outflows during April through June no less than April flows, in the range of 15 kcfs-25 kcfs.

Summer operations: The reservoir was Treaty full by the end of July and passing inflow in August. Inflows in July and August were high, 121% and 140% of average, respectively, due to beyond average precipitation in the area and late snow meltoff. Outflows in August were 83.36 kcfs. In September, reservoir was drafted to elevation of 1442 ft, for whitefish operation in January 2000. It was drafted 315 ksfd in the second half of September for the whitefish operation, through the end of September.

A summary of the average actual (Treaty and Flex Operations) monthly outflows is given in Table A-3.

TABLE A-3. Arrow Dam: Actual Monthly Average Flows

Months	**Monthly Average Flow [kcfs]**
October	29.32
November	31.14
December	40.01
January	50.76
February	76.25
March	37.31
April	20.14
May	25.07
June	19.97
July	49.73
August	83.36
September	62.22

Review of reservoir management in 1999 shows that this year when water was so abundant in the system during summer, spring operations might have been more amenable to fish needs. Flow target at the end of May were not met at McNary, although there was the possibility of releasing higher flows from Arrow (Treaty releases) or from Mica (Non Treaty releases instead of storage at that time) to meet the flow target at that time. Also the shaping of Whitefish operation releases in September 1999 was not favorable for late fall chinook migration, but was favorable for power generation purposes.

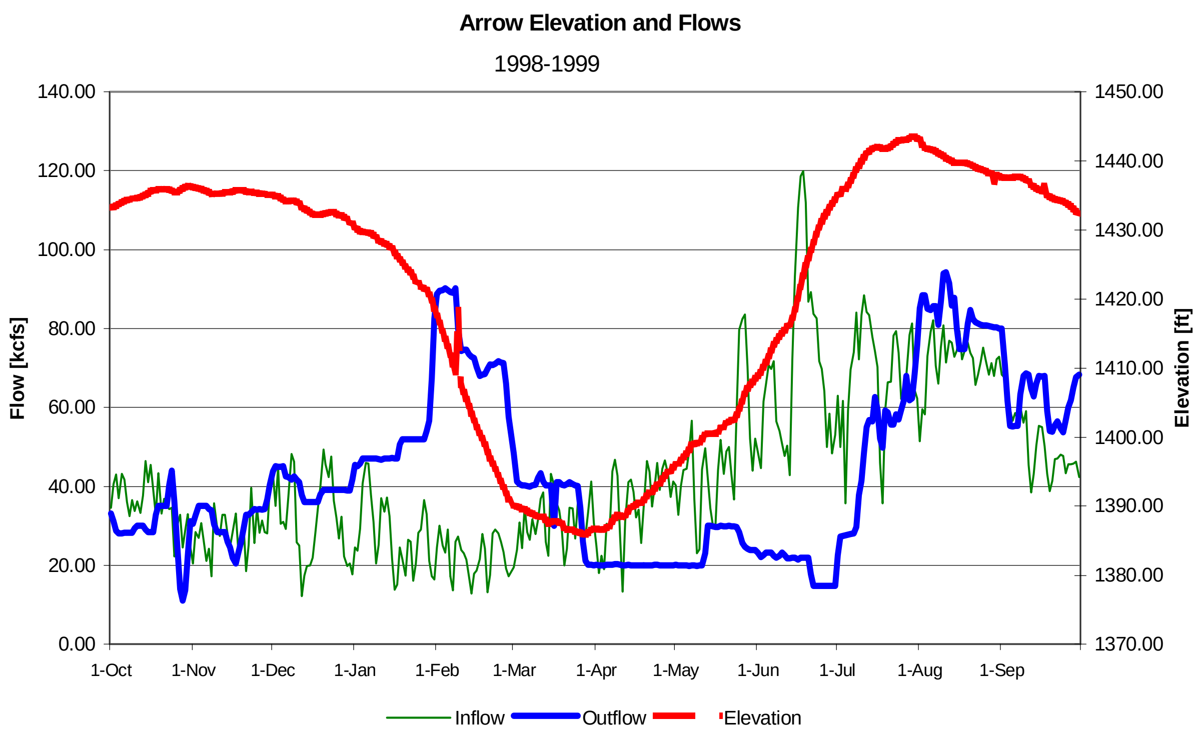

FIGURE A-2. 1999 Arrow Operations

4. Duncan-Figure A-3:

Duncan reservoir was operated for downstream power generation and flood control, maintaining the International Joint Commission required elevations at Kootenai Lake during the year. A summary of the actual end of month elevations and actual monthly average flows is given in Table A-4.

TABLE A-4. Duncan Dam: Actual End of Month Elevations and Monthly Average Flows

Months	Elevation [ft]	Flow [kcfs]
October	1850.03	9.07
November	1830.39	6.04
December	1820.69	0.6
January	1797.93	7.03
February	1794.97	0.98
March	1794.76	0.76
April	1796.29	1.83
May	1814.80	3.14
June	1860.29	0.10
July	1891.94	1.38
August	1891.98	9.56
September	1884.24	5.18

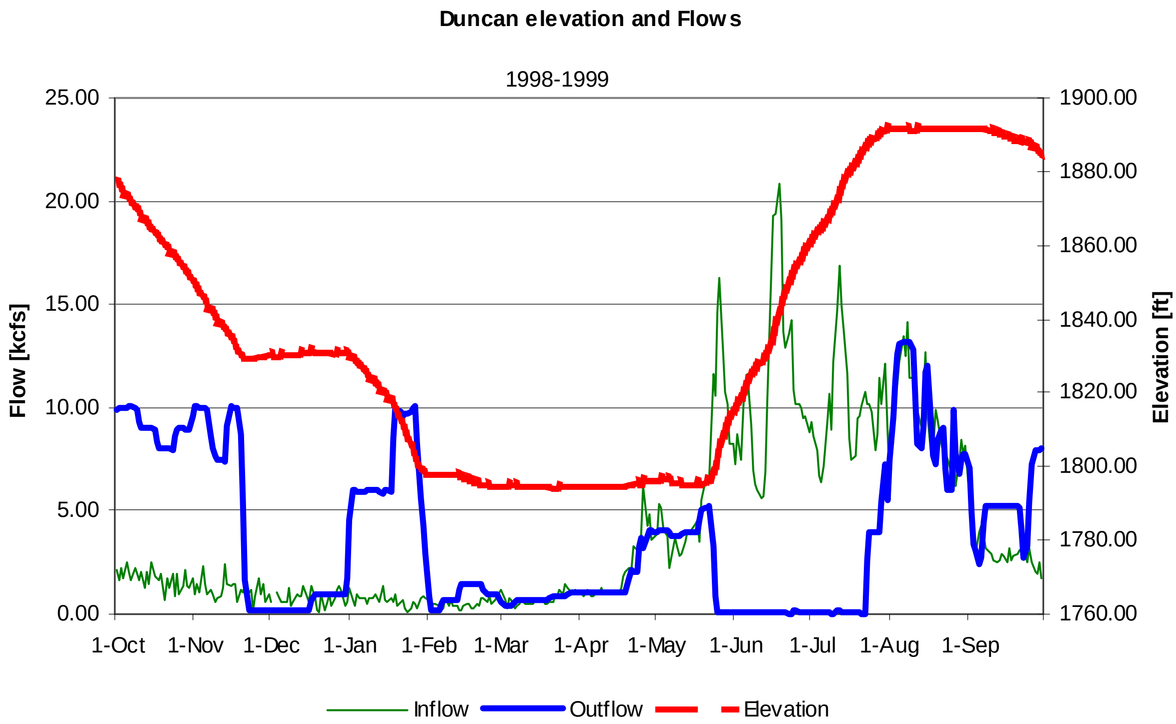

FIGURE A-3. 1999 Duncan Operations

B. Upper and Mid Columbia Basin

1. Hungry Horse-Figure A-4:

Fall/Winter Operations: The reservoir was operated during the October-December period with outflows in the range of 1.8 kcfs-3.5 kcfs to accommodate the minimum required outflow at Columbia Falls of 3.5 kcfs. Average monthly outflows were in the range of 2.16 kcfs-2.22 kcfs for the October-December period. Monthly inflows were 40%, 53% and 63% of average for the October-December period respectively. The reservoir was drafted from elevation of 3535.77 ft on October 1 to elevation of 3522.26 ft through the end of December.

The reservoir was drafted below required flood control elevations during the January-March period because of maintenance work. Runoff volume forecasts for the April-September period were 107% of average in January, 110% of average in February and 114% of average in March resulting in increasing drafts for flood control. The end of January elevation of 3514.3 ft, was 30.3 ft below required flood control elevation. Inflow was 83% of average in January, 65% of average in February and 116% of average in March. The end of February actual elevation was 22.8 ft below the required flood control elevation. The actual elevation of 3485.6 ft at the end of March was 21.5 ft lower than the required flood control elevation.

Spring Operations: In attempt to meet an end of April flood control elevation, the reservoir was refilled 4.3 ft during April, to an elevation of 3489.5 ft, resulting in an elevation 1.5 ft below the required flood control elevation. The 1998 BiOp required the April 10 elevation was 3499.9 ft and actual elevation on April 10 was 3483.2 ft. The failure to be on the BiOp required elevation resulted in 292.3 KAF less water at the beginning of the migration, between April 10 and April 30.

The reservoir was operated according to Integrated Rule Curves defined by State of Montana, during the spring, which prescribed elevation of 3510 ft by the end of May and refill of the reservoir by the end of July, instead of BiOp required full pool elevation at the end of June. Actual elevation at the end of May was 3515.3 ft, and the reservoir was refilled to elevation of 3560.48 ft by July 19, instead on June 30. Actual elevation at the end of June was 3550.97 ft. Failure to be on the required elevation at the end of June resulted in 222 KAF less water in storage for summer migration.

Summer Operations: Federal regulators intended to implement elevations projected by IRC for summer augmentation, but with minimum required flows of 200 kcfs at McNary as the major operating criteria. The operation of delayed refill didn't impact summer flows significantly, as flows were sufficiently high due to weather in system during July-August period due to delayed snow meltoff and high precipitation in the basin. High base flows resulted in decreased need for augmentation flows to meet the 200 kcfs from the Upper Columbia reservoirs, and Hungry Horse was drafted only to elevation of 3554.25 ft through the end of August, instead of the BiOp required elevation of 3540 ft. Average July outflow was 2.16 kcfs and average August augmentation outflow was 3.68 kcfs. The reservoir was drafted to an end of September elevation of 3544.8 ft with an average outflow of 4.21 kcfs for the late fall chinook migration, but also for the purposes of power generation. Federal regulators viewed Salmon Managers request in September, as outside the Biological Opinion and therefore did not consider it with any priority for implementation. Actual flows at McNary were lower than requested in the first part of September and higher than requested in the second half of September. Adequate management of Hungry Horse and Libby could provide flows as requested. One of the options was drafting Hungry Horse at higher rate of 7.5 kcfs instead of 4.5 kcfs during the first two weeks of September. Instead, Federal regulators operated system primarily for power generation purposes.

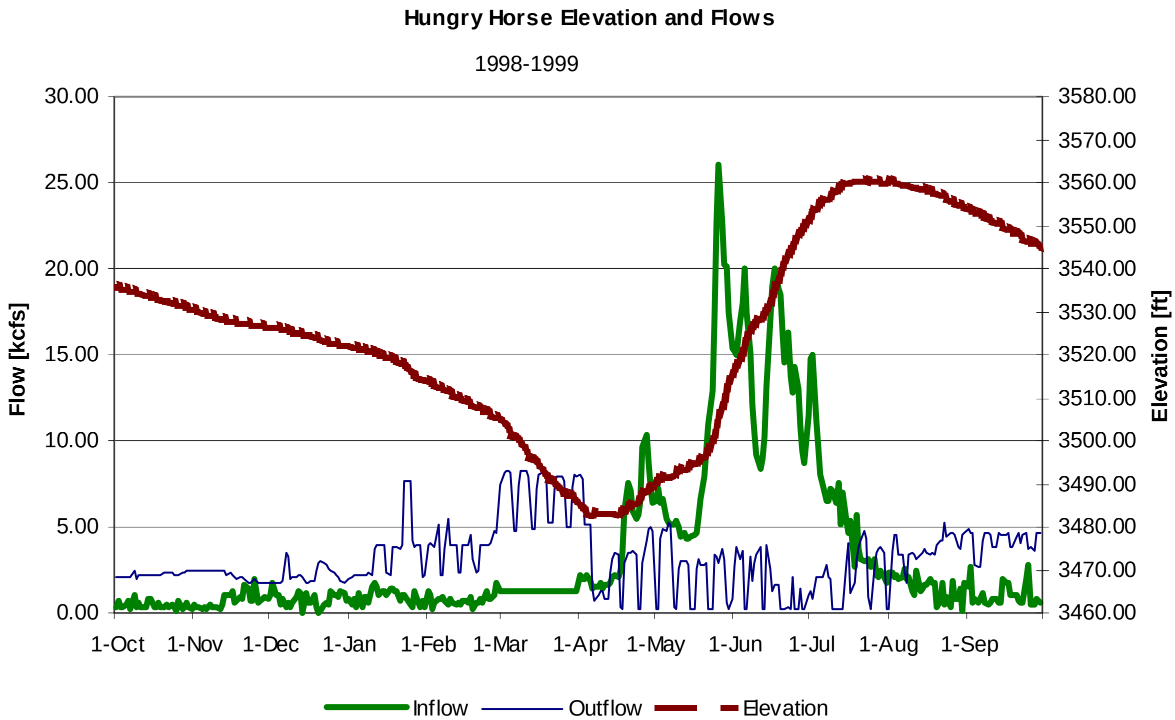

FIGURE A-4. 1999 Hungry Horse Operations

2. Libby: Figure A-5

Fall/Winter Operations: Libby was operated for power generation in October through December period. The reservoir commenced fall draft from elevation of 2437.72 ft on October 1 to elevation of 2405.6 ft by December 31. The outflows were in the range of 4-8 kcfs during October-November 29 period because of low October and November inflows of 73% and 80% respectively. Outflows from Libby were increased to 9 kcfs at the beginning of December as the inflows increased to 95% of average and the reservoir was drafted to elevation of 2405.6 ft at the end of December.

Libby was drafted to flood control elevations during the January-February period. At the beginning of March the COE decided to operate Libby at minimum outflow in order to achieve the April 15 flood evacuation point with 75% probability.

Spring Operations: The reservoir was operated at 4 kcfs beginning on March 12 through June 13 in order to refill through the end of June, anticipating the request for the sturgeon spawning pulse. Although the reservoir was 4.2 ft above the 1998 BiOp required flood control elevation on April 10, it was not refilled by June 30. Actual elevation on June 30 was 2432.94 ft. Significant variation in runoff volume forecast from 111% of average in March to 106% of average in May, low spring temperatures and delayed snow melt with sturgeon flow requirements resulted in failure to refill the reservoir. Monthly inflows were 116% of average in March, 117% of average in April, 88% of average in May and 103% of average in June.

Summer Operations: The sturgeon pulse and following incubation flow in the range of 16.8-25 kcfs finished at July 6 at elevation of 2436 ft. High precipitation in August resulted in inflows of 151% of average and increased outflows for local flood control. Reservoir was full on August 9. Augmentation commenced on August 23, at rates between 14.7-19 kcfs, sufficient enough to meet minimum flow target at McNary. The end of August elevation was 2455.63 ft. The reservoir continued to be drafted in September at rate of 12 kcfs to 2449.12 ft. Federal regulators failed to operate the reservoir in a manner to improve flows for the late fall chinook migration. This need was not included in the 1998 BiOp. Increase in flows to 20 kcfs from 12 kcfs and to 16 kcfs from 12 kcfs respectively, during first two weeks of September would have improved early September flows.

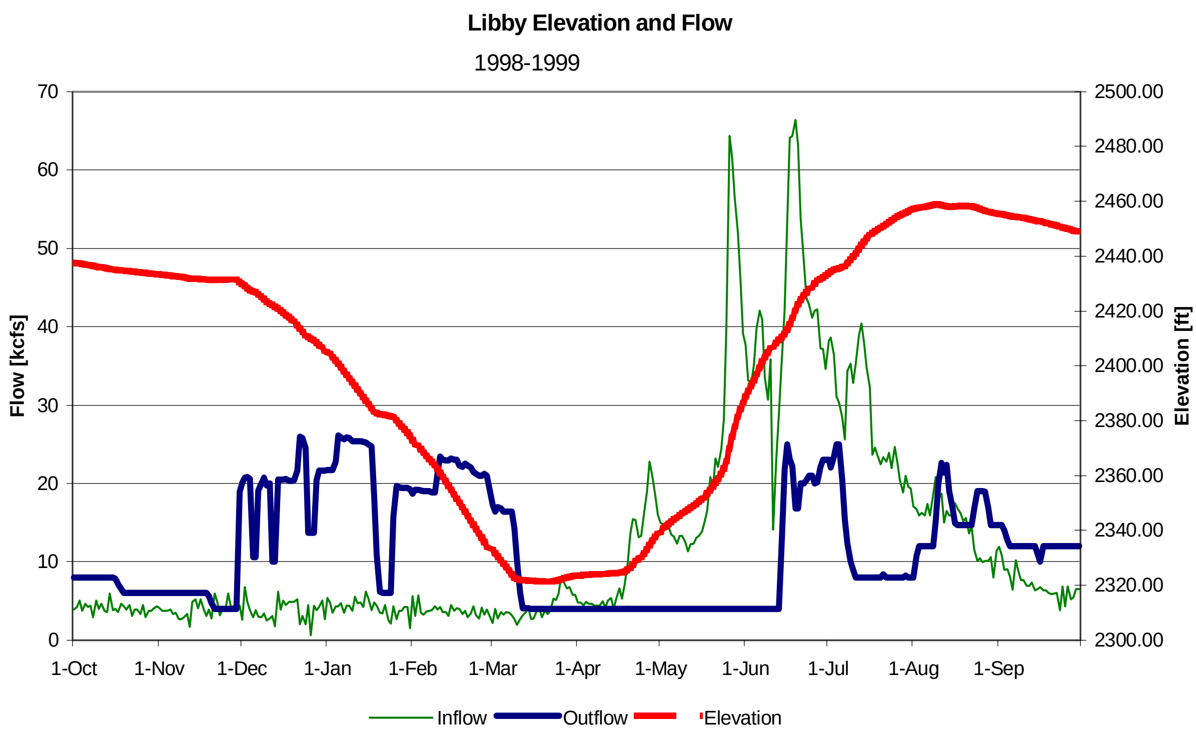

FIGURE A-5. 1999 Libby Operations

3. Grand Coulee: - Figure A-6

Fall/Winter Operations: Grand Coulee was refilled to 1283 ft by the end of October and remained above elevation 1280 ft until mid December. The reservoir was mainly operated for power generation purposes and maintaining Vernita Bar agreement flows during the October-December period. Inflows were 92%, 98% and 112% of average for the October-December period. Average monthly outflows were 65.5 kcfs, 75.95 kcfs and 95.5 kcfs respectively. As the precipitation in the basin increased, the outflows from Grand Coulee and other reservoirs increased in mid December. The reservoir was operated above 1280 ft during the October-November period, with end of December elevation of 1278.4 ft.

The reservoir was overdrafted for power generation during January-February period, passing inflow at elevation of 1264-1265 ft in February and drafted to elevation of 1246.8 ft by the end of March, which was 0.9 ft below end of March flood control elevation. The average January outflow was 130.04 kcfs with range of 93.6 kcfs-156.98 kcfs, average February outflow was

135.6 kcfs with range of 90.3 kcfs-170.8 kcfs and March outflow was 127.9 kcfs with a range of 85.5 kcfs-159.1 kcfs.

Spring Operations: The reservoir was 1.8 ft below the BiOp required April 10 elevation, with wide fluctuations in outflows in the range of 89.4 kcfs-166.1 kcfs during April, significantly impacting fluctuations below Priest Rapids Dam. Cold weather, delayed snowmelt and low precipitation in the region of about 60%-70% of average in May resulted in low flows at McNary, in the peak of spring chinook migration. Salmon Managers requested flow augmentation from Grand Coulee to improve flows in the lower Columbia. The reservoir was passing inflow or drafting during May 10-19 at rates between 127.7-153.8 kcfs to support higher flows at Priest Rapids and McNary. The reservoir draft limit of 1 ft/day was an obstacle to meeting flow targets in the May 10-16 period. The lowest elevation that the reservoir reached was 1213.4 ft on May 19. Inflows into the reservoir were 92% and 91% of average during the May-June period. The reservoir was refilled by July 12. The failure to refill the reservoir by June 30 resulted in 433 KAF of water shifted from summer into spring.

Summer Operations: The reservoir was slightly drafted to elevation of 1287.3 ft by July 27, then refilled to elevation 1289.9 ft on August 11. Inflows in July and August were 104% and 135% of average due to above average precipitation in August at Coulee of 131% of average. Drafting for augmentation continued from August 12-31 at rates in the range of 128.6 kcfs-184.8 kcfs. The actual elevation at the end of August was 1286.4 ft. All of the BiOp recommended augmentation volume was not drafted for the fish migration. A total of 411 KAF remained in the reservoir at the end of summer.

The reservoir continued to be managed for power generation, and late fall chinook migration, maintaining an elevation of 1284 ft for kokanee spawning. The lowest elevation was 1283.8 ft on September 23. The actual end of September elevation was 1285.3 ft. Inflows were 134% of average and outflows were in range of 92.1 kcfs-133.4 kcfs.

Flexibility in Coulee's reservoir management was not used to its full extent to meet flows at McNary as requested by Fishery Agencies in the second half of September. The reservoir was held at higher elevations of 1285.3-1286.2 ft during September 13-19 period, instead of being drafted approximately 1 ft for requested flows at McNary.

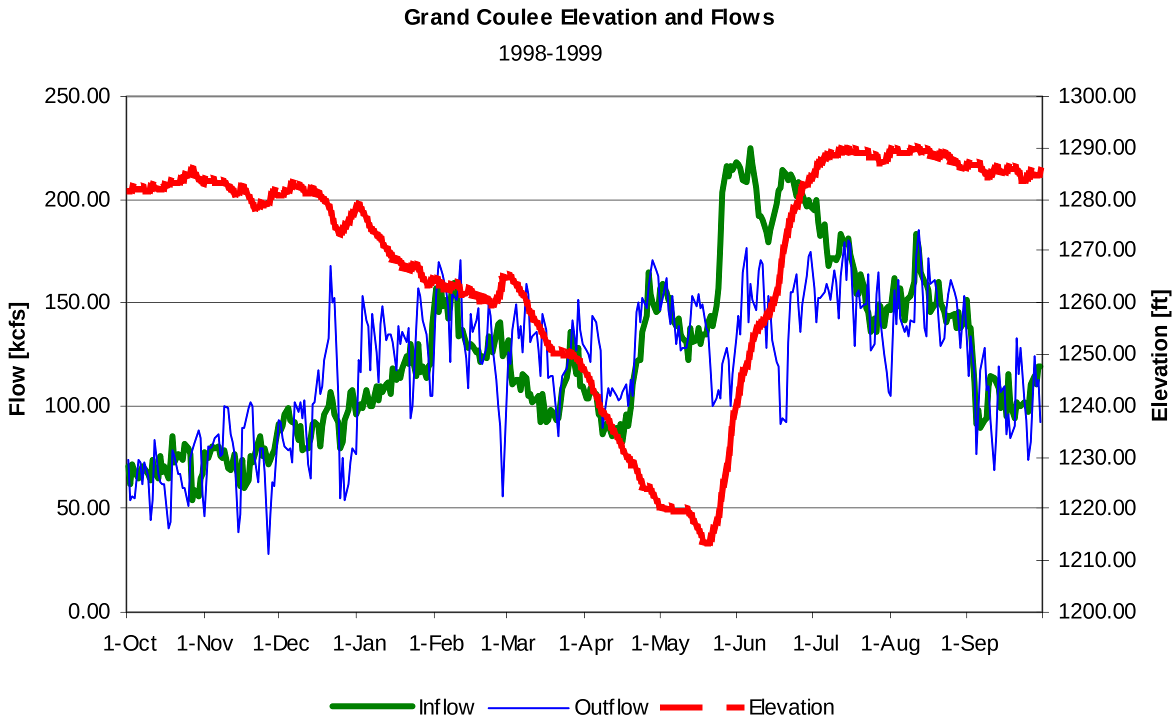

FIGURE A-6. 1999 Grand Coulee Operations

C. Snake River Basin

1. Dworshak:-Figure A-7

Fall/Winter Operations: Reservoir was at elevation of 1519.1 ft on October 1. It was operated at minimum draft rate of 1.3 kcfs-1.4 kcfs through December 31, when elevation of 1533.4 ft was reached. The lowest elevation was 1517.08 ft on November 11. Inflows were in the range of 0.6 kcfs-6.3 kcfs, or monthly averages were 66%, 110% and 116% of average for October-December period respectively. On January 6, the reservoir began flood control draft, increasing outflow to 10.7 kcfs in January-March period. Average monthly inflows were 139%, 89% and 139% of average during the January-March period. The reservoir was drafted to elevation of 1519.9 ft at the end of January, which is 6.3 ft below the required end of January flood control elevation. The actual elevation of 1489.21 ft at the end of February was only 2.29 ft below the required flood control elevation. The runoff Volume Forecast increased from a steady value of 115% of average in the January-February period to 133% of average in March. This increase resulted in deep drafts for flood control in March. The reservoir was drafted to flood control elevation, during March with outflows in the range of 10.6 kcfs-14 kcfs through March 27. Increased temperatures caused local snowmelt and increased inflows. Federal regulators were unable to draft the reservoir to required flood control without spilling and exceeding TDG limit of 110% in the tailwater. The actual end of March elevation was 1456.21 ft, which is 11.21 ft above required flood control elevation. During the period of March 28-April 2 the reservoir was drafted at a higher rate of 16 kcfs.

Spring Operations: The reservoir continued to be drafted for flood control during the period of April 3-17 at rates of 8 kcfs-12 kcfs, being held at elevation of 1445.3 ft-1445.5 ft during April 9-16, for flood control. The runoff volume forecast decreased to 126% of average in April, but still resulted in the same required flood control elevation of 1445 ft at the end of March. The end of April actual elevation was 1453.4 ft. The combination of a cold weather, delayed snowmelt and conservative flood control operations resulted in flows at Lower Granite lower than the BiOp required minimum of 100 kcfs at the beginning of May, when there were significant numbers of juvenile spring chinook migrants in the river. Fishery Agencies requested drafting of the reservoir to meet the BiOp flow target. However, the outflows were limited to 14 kcfs with allowed TDG level of 110% in the tailrace of the dam by the State of Idaho failure to issue a dissolved gas waiver. The reservoir was drafted through May 17, and natural flows increased resulting in refill at minimum outflows of 1.4 kcfs on May 20. The May Final runoff volume forecast decreased further from 126% to 119% and combined with drafts of the reservoir in April for flood control and drafting for augmentation at May 8-16 resulted in failure of the reservoir to be refilled by June 30. The reservoir was refilling through July 15. Runoff Volume forecasts continued to decrease to 114% of average. Outflow increased to 14 kcfs from April 18, first for flood control and then for augmentation flows through May 19. Refill started on May 20. The maximum elevation reached was 1593.4 ft, instead of the BiOp required elevation of 1600 ft. The failure to refill to full pool elevation resulted in 123 KAF less water for summer augmentation.

Summer Operations: The rate of flow augmentation during the period of July 16-August 31 was dependent on the issuance of TDG waiver by EPA. Fishery Agencies requested drafting at rate of 14 kcfs of Dworshak in order to maintain 55 kcfs at Lower Granite during July 15-25 period. The COE delayed drafting the reservoir increasing the drafting rate over the weekend of July 17-18, to maintain higher pool elevations. The drafting rate was in the range of 13.2-13.9

kcfs during July 19-23. The dissolved gas limit of 110% saturation was reached with outflows of 12.8 kcfs. The flows were maintained at 12.8 kcfs. With decreasing base flows at Lower Granite the agencies requested an increase in outflow to 19 kcfs. Because of the issuance of TDG waiver, the request was implemented beginning on July 31. Fishery Agencies requested drafting at the continued rate of 19 kcfs through August 15. EPA granted TDG waiver only for gradual ramping down of flows to 15 kcfs for the week ending August 15, and to 12.6 kcfs for the week ending August 22. Fishery Agencies requested drafting of the reservoirs at rate of 10 kcfs in the period of August 23-30. Federal regulators operated the reservoir in agreement with Fishery Agencies to elevation of 1526.6 ft on August 30 and continued drafting for augmentation of late fall chinook at rate of 7.8 kcfs to elevation of 1521.5 ft on September 5. The BiOp required elevation of 1520 ft was finally reached on September 14 at rate of 2.4 kcfs. The reservoir was drafted at the minimum rate of 1.5 kcfs by the end of September.

Dworshak augmentation water was used for temperature control on the request of Fishery Agencies. The temperature of the released water was between 47 and 50 degrees accommodating the needs of the Dworshak Hatchery.

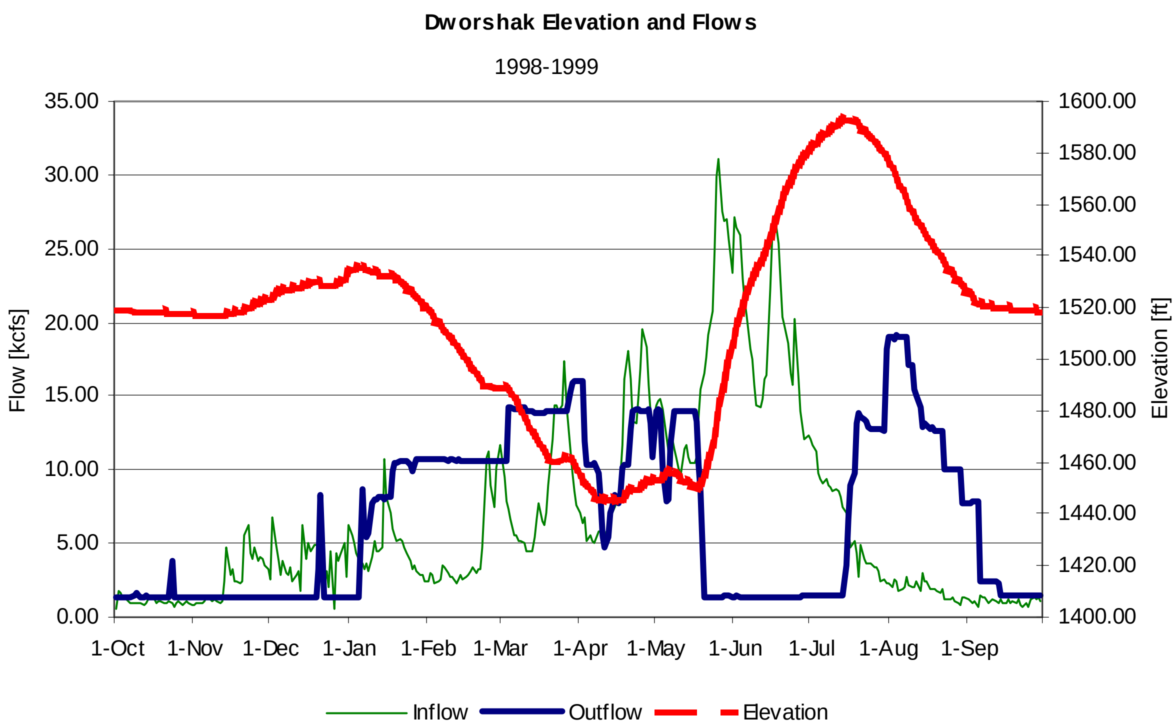

FIGURE A-7. 1999 Dworshak Operations

2. Brownlee-Figure A-8

Fall/Winter Operations: Brownlee began October at elevation of 2019.7 ft. The pool continued to draft, with an average outflow for October 1-17 of 19.98 kcfs, for power generation purposes and to manage flows to limit fall chinook spawning areas. The reservoir was drafted to an elevation of 2003.11 ft on October 17 when outflows were reduced to maintain 9.5 kcfs for spawning of fall chinook below Hells Canyon Dam. The reservoir was operated at that level of outflow until December 7, to 0.7 ft below full pool elevation of 2076.3 ft. Average inflows for October-December period were 97% of average, 100% of average and 120% of average, respectively. Average outflow from Brownlee reservoir for period of October 18-December 7 was 9.41 kcfs in accord with fall chinook spawning area limitation. Actual end of December elevation was 2072 ft and the average outflow for the period of December 8-31 was 22.4 kcfs.

The reservoir was drafted for flood control during the January-April period. Runoff Volume forecasts for the April-July period were increasing from 99% in January to 102% in February and 145% in March. The reservoir was overdrafted for power generation purposes during January, resulting in an end of January elevation of 2054.8 ft, which was 22.2 ft below the required flood control elevation. Average inflow was 23.14 kcfs, or 121% of average, with range of 20.78 kcfs-27.35 kcfs and average outflow was 26.9 kcfs. The IPCo continued drafting for power generation in February, with average outflow of 29.29 kcfs and inflow of 26.67 kcfs, 119% of average, in the range of 19.8 kcfs-46.56 kcfs. The end of February actual elevation was 2042.3 ft, which was 2.2 ft below required flood control elevation. The reservoir was operated for flood control primarily in March, with an end of month elevation of 2006.34 ft, which was only 0.46 ft below the required flood control elevation. The average daily inflow in March was 43.33 kcfs, or 168% of average, within range of 35.1 kcfs-58.5 kcfs and average daily outflow was 48.82 kcfs.

Spring Operations: Runoff Volume forecasts decreased to 127% of average and to 126% of average respectively for the April-July period in April and June. The reservoir was drafted for flood control in April, with an April 20 resulting elevation of 1991 ft, which was 3 ft above BiOp required elevation remaining at higher elevation than required flood control elevation through the end of April. Actual elevation at the end of April was 1990.54 ft, what was 14.5 ft above required FCE, due to high inflows of 136% of average and desired action of IPCo to minimize spill at Hells Canyon Dam. The average daily inflow was 39.5 kcfs with range of 33.6 kcfs-50.6 kcfs and average daily outflow of 42.3 kcfs. Idaho Power Company (IPCo) continued with passing inflow and slightly refilled to elevation of 1991.2 ft through May 9, when it commenced refill at higher rates. Fishery Agencies requested that the reservoir pass inflow during May 11-18 to improve the low flow at Lower Granite. IPCo declined to pass inflows in order to avoid spill at Brownlee and Hells Canyon Dams. The requested action would improve flows at Lower Granite by 6.3 kcfs on average, with a range of 4.14 kcfs-11.71 kcfs. The reservoir was refilled by the end of June to elevation of 2076.08 ft. The differential volume to full pool elevation was 13 KAF.

Summer Operations: Fishery Agencies requested flow augmentation to meet the weekly flow average of 57 kcfs during the period of July 4-11 and 55 kcfs through July 18 on the basis of fish passage monitoring. Draft limitation at the Hells Canyon complex precluded meeting the target flow from July 12-18. Brownlee reservoir is limited to a draft of 1-1.22 ft/day. The BiOp required augmentation volume of 237 KAF was delivered through July 26. IPCo shaped 75 KAF of BOR augmentation water from Payette River through the end of July. Average July inflow was 14.4 kcfs, or 114% of average, with daily inflows in the range of 10.9 kcfs-24 kcfs. Average July outflow was 19.33 kcfs. The reservoir was slightly drafted to 2049.8 ft by the second week of August and to 2045.6 ft by the end of August. Average August inflow was 12.81 kcfs, or 116% of average with daily flows in the range of 11.1 kcfs-14.8 kcfs. Due to favorable market conditions, IPCo drafted to 2039 ft by the end of September, with an average outflow of 13.6 kcfs. Average monthly inflow was 13.1 kcfs or 96% of average, with daily flows in the range of 11.5 kcfs-15 kcfs.

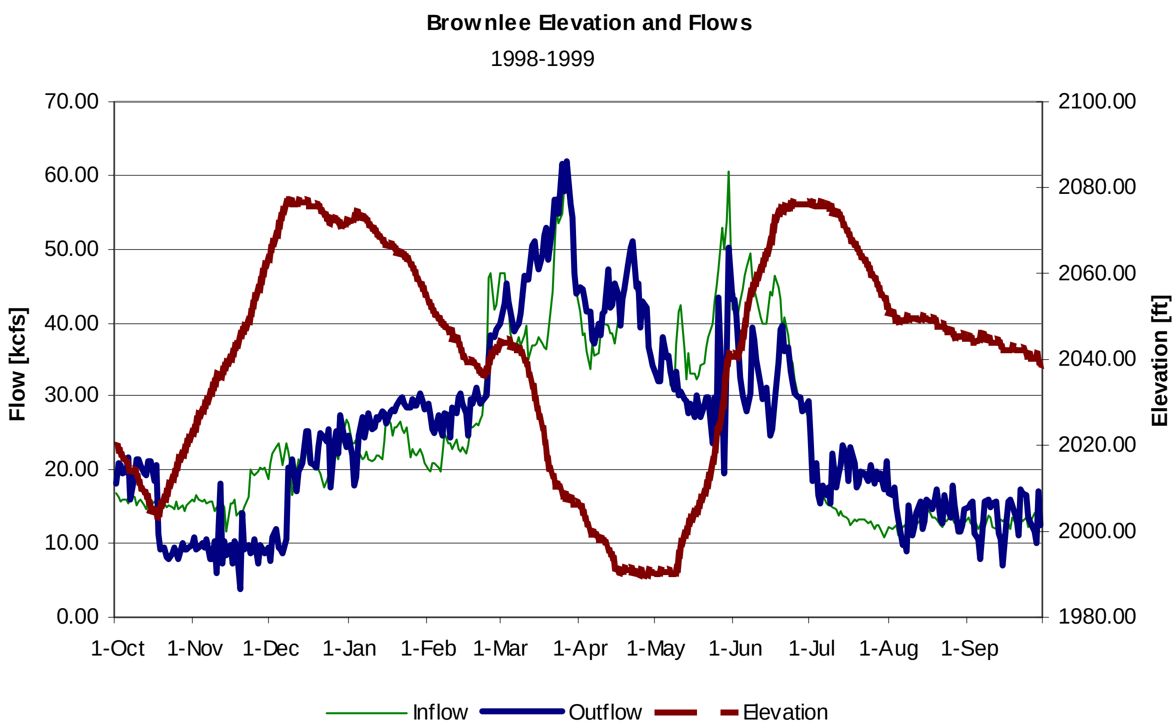

FIGURE A-8. 1999 Dworshak Operations

Upper Snake Reservoirs:

The Upper Snake basin contributes to augmentation flows as the part of Bureau of Reclamation obligation for summer augmentation for the Lower Snake. The subbasin consists of 8 reservoirs, plus the smallest reservoir just upstream from Milner gage, at the most downstream point in the subbasin. The system has been developed for flood control protection of the area, irrigation and power generation. Three of the largest and most significant reservoirs in the system are Jackson Lake, Palisades, and American Falls.

A summary of the Final Runoff Volume Forecasts at Weiser, upstream from Milner is given in the Table A-5.

TABLE A-5. Monthly Final Runoff Volume Forecast at Weiser

Months	Volume [MAF]	% of (1961-1990) Average
January	5.3	97
February	5.57	102
March	7.95	145
April	6.95	127
May	6.87	126
June	6.83	125

Precipitation was low in December and March with 69% and 62% of average. February was the highest winter month with 138% of average. Precipitation was above average during the whole spring with the highest record in June with 143% of average. Monthly fluctuations were highly pronounced in summer with recorded July precipitation of 58% of average, September precipitation of 14% of average and August precipitation with recorded 123% of average.

Jackson Lake and Palisades reservoirs:

Both reservoirs are operated as a multipurpose unit for local flood control, irrigation, recreation, and power production. Active Storage includes 847 KAF in Jackson Lake and 1200 KAF in Palisades reservoir, for a combined total of 2047 KAF. Runoff Volume Forecasts for Heise, ID, were gradually increasing through the season, from 105% in February to 124% in March, due to increase in snowpack and very high precipitation in February, of 138% of average. The final July Runoff Volume Forecast remained at 124% due to high precipitation in June of 134% of average. A Summary of Runoff Volume Forecasts is given in the Table A-6:

TABLE A-6. Final Monthly Runoff Volume Forecasts for Heise, Idaho

Months	Volume [MAF]	% of (1961-1990) Average
January	3.47	101
February	3.64	105
March	4.27	124
April	4.0	116
May	4.11	119
June	4.04	117
July	4.27	124

A summary of the end of month changes in the reservoir storage is given in the Table A-7:

TABLE A-7. Monthly Jackson and Palisades Reservoir Storage Status

Months	Volume in KAF			
	Palisades	Jackson Lake	Total Volume	Percent of Total
October	956.4	571.8	1528.2	74.66
November	996.1	580.8	1576.9	77.04
December	1007.3	590.03	1597.33	78.03
January	995.96	606.9	1602.86	78.3
February	839.3	623.4	1462.7	71.5
March	573.7	596.7	1170.4	54.25
April	355.5	533.1	888.6	43.4
May	523.3	646.0	1169.3	82.7
June	1092.7	793.0	1885.7	92.1
July	1128.6	832.5	1961.1	95.8
August	999.8	752.5	1752.3	85.6
September	904.4	651.6	1562.0	76.01

Discharge from the Palisades reservoir is measured at the Snake River near the Irwin, Idaho, gage. A summary of the monthly average flows at Irwin is given in Table A-8:

TABLE A-8. Monthly Average Flows at Irwin Gage

Month*s*	**Monthly Average Flow [kcfs]**
October	3.6
November	2.5
December	2.48
January	2.85
February	5.61
March	8.63
April	9.59
May	13.03
June	17.91
July	12.29
August	9.18
September	7.83

Fall/Winter Operations: Reservoirs were drafted for irrigation through mid-October, and then passed inflow with slight refilling through the end of December. At the end of October the storage was 67.5% of full and at the end of December the storage was 69.7% of full. The average monthly outflows at Irwin were in the range of 2.5 kcfs-3.6 kcfs. Due to high precipitation in February and in anticipation of the high spring runoff the system was conservatively drafted to 71.5% of the total storage in February and to 54.25% of the total storage in March. The monthly average outflows were 2.85 kcfs and 8.63 kcfs.

Spring Operations: Like previous years, the system was predrafted in winter period in anticipation of the high runoff in spring. The major flood control requirement for Jackson Lake and Palisades is to be operated as a system to limit the maximum flow at the Heise stream gauge to 20 kcfs. Historically, it has been shown that maximum flows occur in May and June, when the reservoirs are refilling.

The system continued to be drafted for flood control in April to 43.3% of the full capacity. The average weekly outflows were in the range of 8.8 kcfs-11 kcfs. At the same time, after low precipitation of 62% of average in March and snow meltoff at the end of March, the April Final Runoff Volume Forecast significantly decreased to 116%, by 0.73MAF. In 1998 Salmon Managers request for different spring management of the system was denied. It has been shown in the last few years that the spring flow target at Lower Granite is not being met at the beginning of the migration season on a weekly basis. If the system had been passing inflow in March, and then drafted in April, the monthly average flows would be improved by 9.35 kcfs, and the objective of below 20 kcfs at Heise would have been met. The system was refilling during May and June as a combined operation for irrigation and flood control. The average May outflow was 13.03 kcfs, and due to above averages precipitation the system had been refilled to 82.7% of full. The July Final Runoff Volume Forecast increased to 124% of average due to precipitation of 143% of average in June. The system has been refilled to 92.1% of average by the end of June. The average monthly outflow was 17.91 kcfs.

Summer Operations: The system was refilled to 99% of capacity by the end of the second week of July. Intensive irrigation withdrawals commenced at the end of July at rates in the range of 7 kcfs-10 kcfs through the second week of October. The average flows at Irwin were 12.29, 9.18 and 7.83 kcfs, during July, August and September, respectively. At the end of September, 1.54 MAF of water remained in the system.

American Falls Reservoir:

The project is operated for irrigation, power and flood control. The major irrigation diversion below American Falls is at Minidoka. The active capacity of the reservoir is 1.68MAF. The

Final Runoff Volume Forecast at Weiser increased from 97% of average in January to 145% of average in March and decreased to 125% of average in June. A summary of the Final Runoff Volume Forecasts for the season at Weiser, ID, is given in the Table A-9.

TABLE A-9. Monthly American Falls Reservoir Storage Status

Months	Volume in KAF	
	Total Volume	Percent of Total [%]
October	1032.7	61.7
November	1232.2	73.7
December	1173.03	70.13
January	1144.9	68.5
February	1261.9	75.4
March	1501.8	89.8
April	1571.1	93.9
May	1594.9	95.3
June	1671.4	99.9
July	1234.2	73.8
August	891.0	53.3
September	704.5	42.1

The resulting discharges from the entire Upper Snake system are measured at the Milner gauge, ID. A summary of the monthly average Milner flows is given in the Table A-10.

TABLE A-10. Monthly Average Flows at Milner, Idaho

Months	Monthly Average Flow [kcfs]
October	1.87
November	4.52
December	8.08
January	8.11
February	7.85
March	7.63
April	10.02
May	10.36
June	11.73
July	1.54
August	1.56
September	1.29

Fall/Winter Operations: The reservoir was refilled from 50.7% of capacity at the end of September 1998 through October-November period as a part of flood control operations to 70% of capacity. In anticipation of the high spring runoff, the reservoir was refilled only to 89.8% of full capacity through the end of March.

Spring Operations: The April Final Runoff Volume Forecast decreased compared to the March Final by 1 MAF and the reservoir was refilled to 93.9% of the full capacity by the end of April. Average outflow in April at Milner was 10.02 kcfs. Refill continued through the end of June, when the reservoir was full. Average flows in May and June were 10.36 kcfs and 11.73 kcfs kcfs.

Summer operations: Intensive drafting for irrigation started in July at rates of 6-9 kcfs. The reservoir was drafted 437 KAF to 73.8% of the full capacity for irrigation and salmon flow augmentation. Flow augmentation started on July 1 and continued through the end of August. The reservoir was drafted to 53.3% of the full capacity through the end of August and to 42.1% through the end of September. A total of 704.5 KAF of water remained in the reservoir at the end of September. Irrigation surpluses and flood control releases in September resulted in average outflow of 1.5 kcfs at Milner. The BOR delivered irrigation surplus water in the period of September 1-15 and IPCo delivered its portion of 45 KAF of flood control water from American Falls through the first week of October.

APPENDIX B

Total Dissolved Gas Saturation Plots

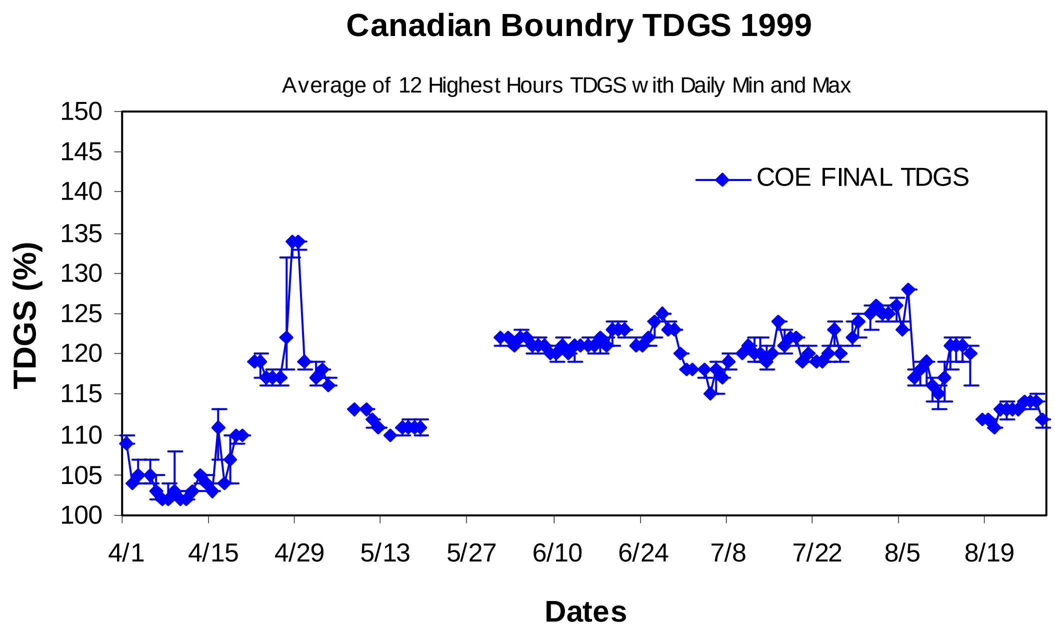

FIGURE B 1. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Canadian Boundary.

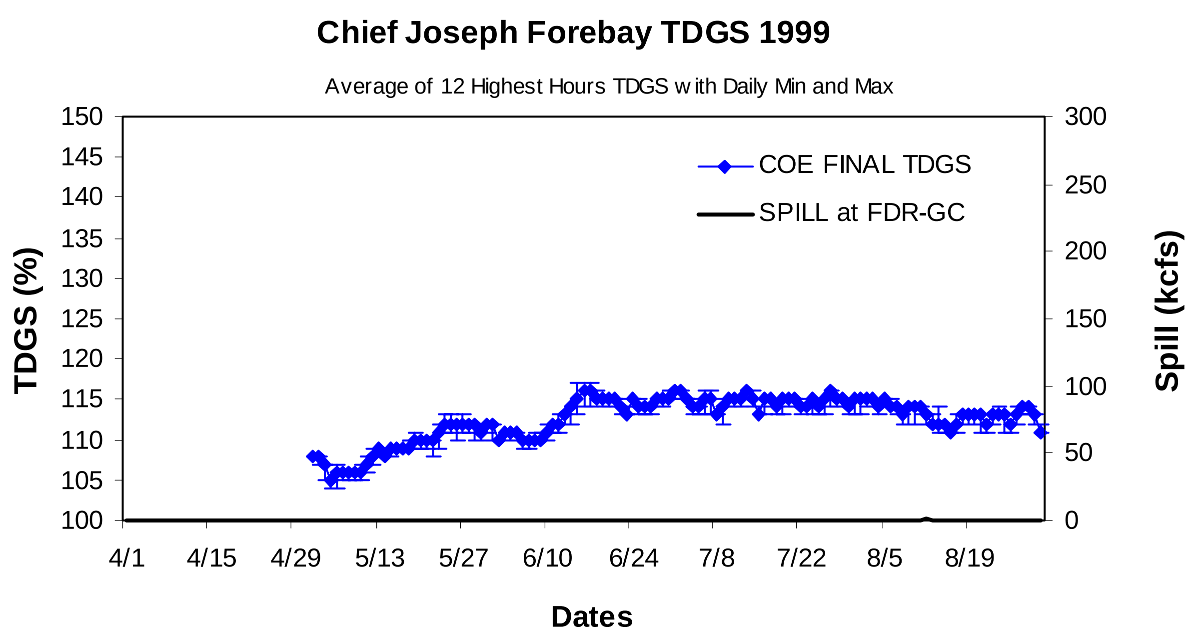

FIGURE B-2. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computer from COE final database (COE TDGS) at Chief Joseph Forebay.

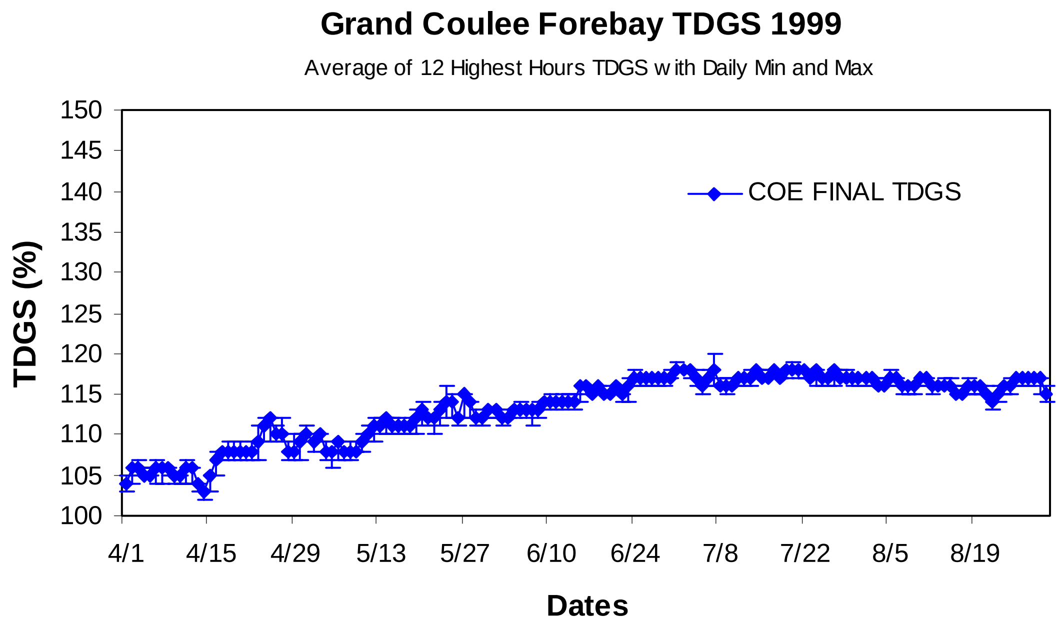

FIGURE B-3. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Grand Coulee Forebay.

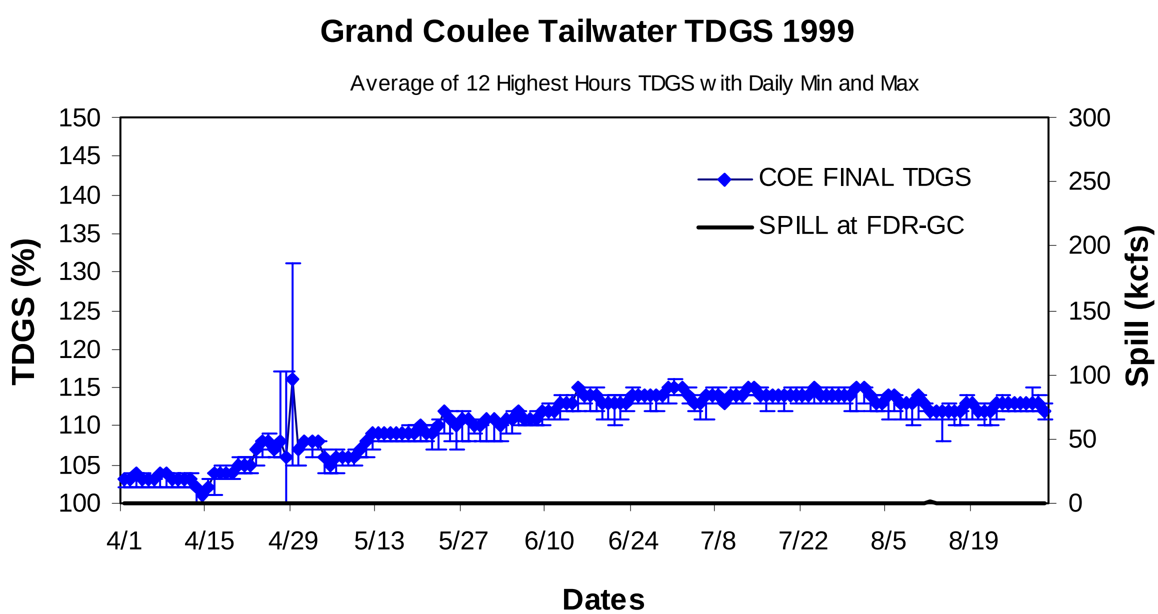

FIGURE B-4. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Grand Coulee Tailwater.

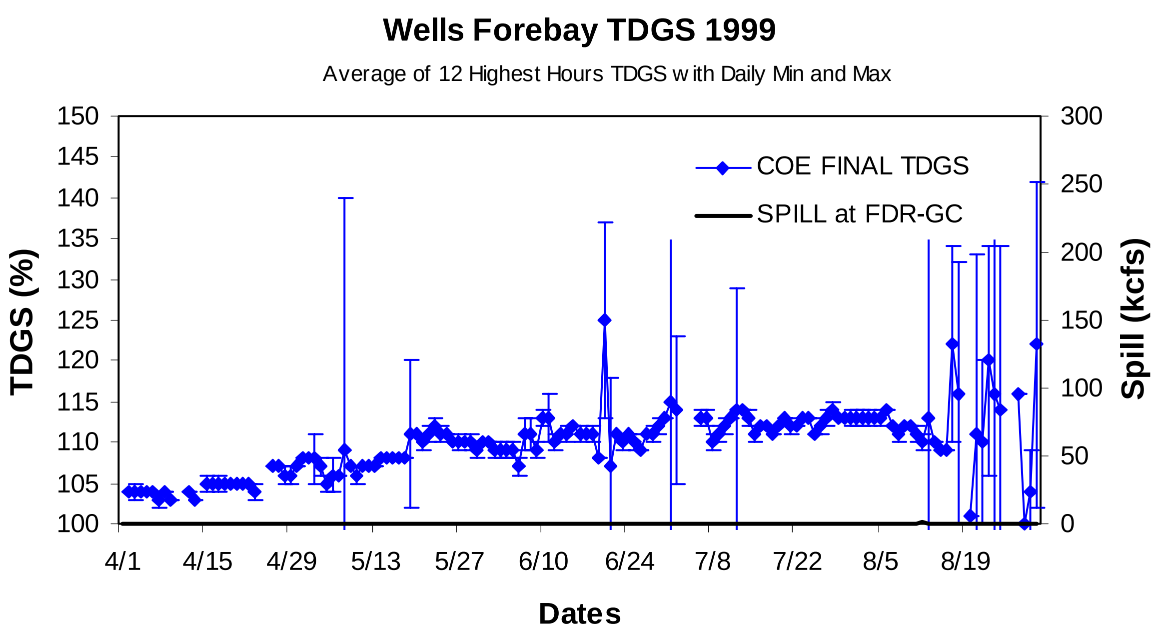

FIGURE B-5. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Wells Forebay.

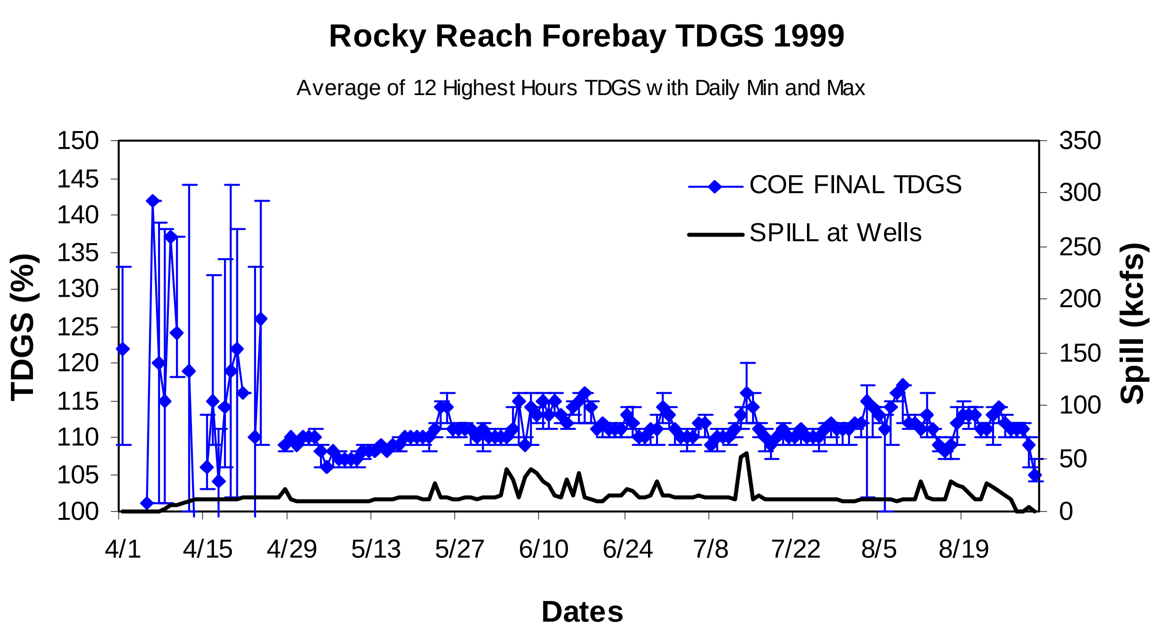

FIGURE B-6. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Rocky Reach Forebay.

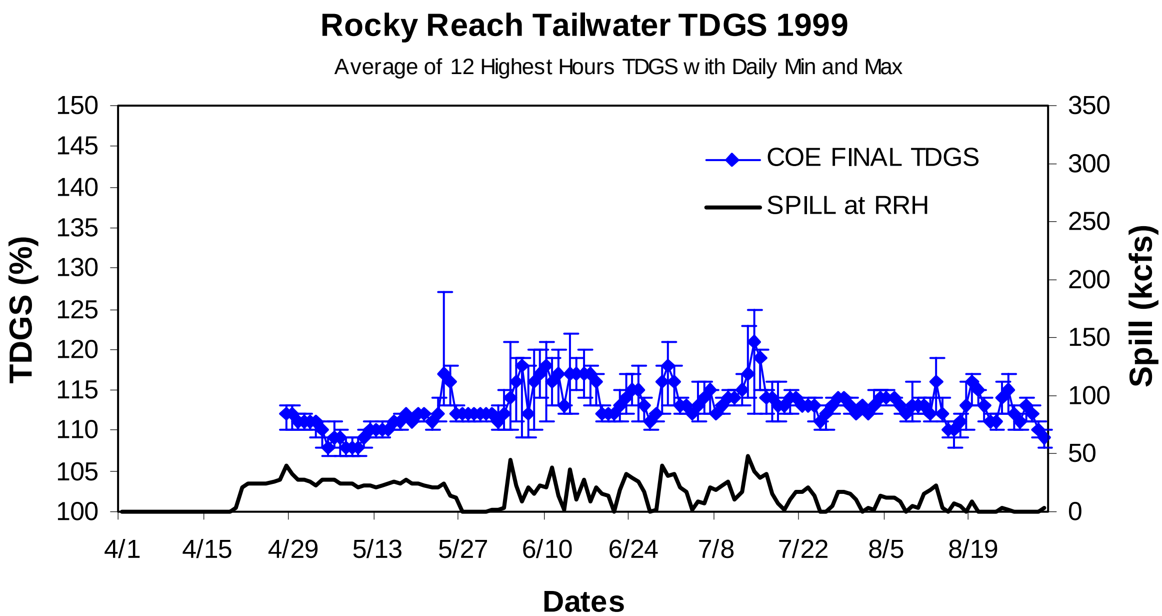

FIGURE B-7. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Rocky Reach Tailwater.

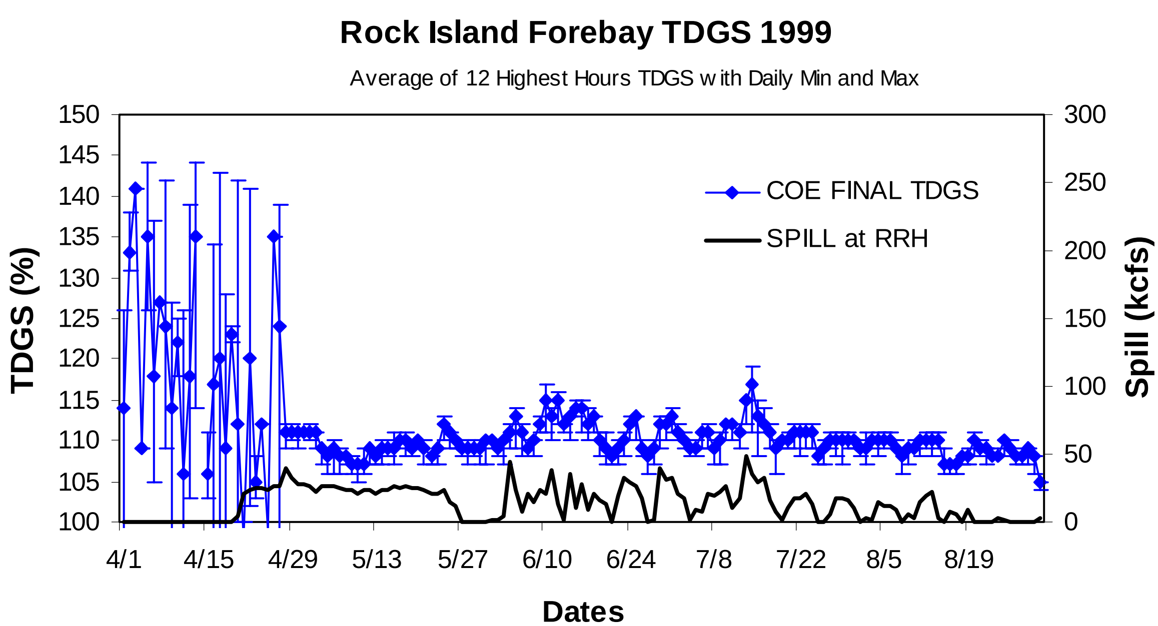

FIGURE B-8. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Rock Island Forebay.

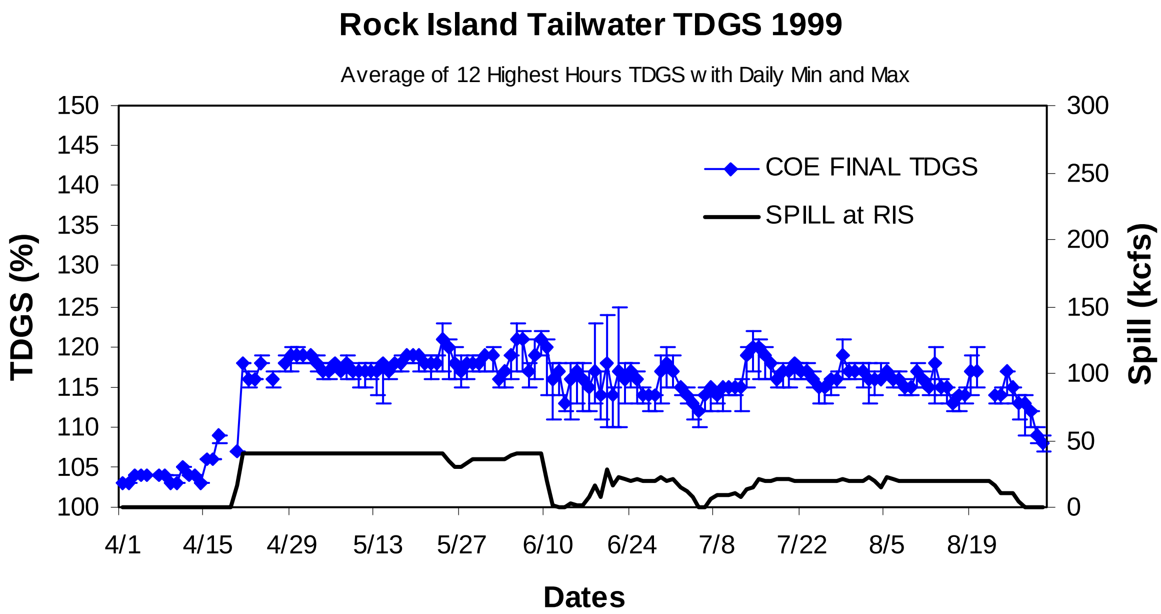

FIGURE B-9. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Rock Island Tailwater.

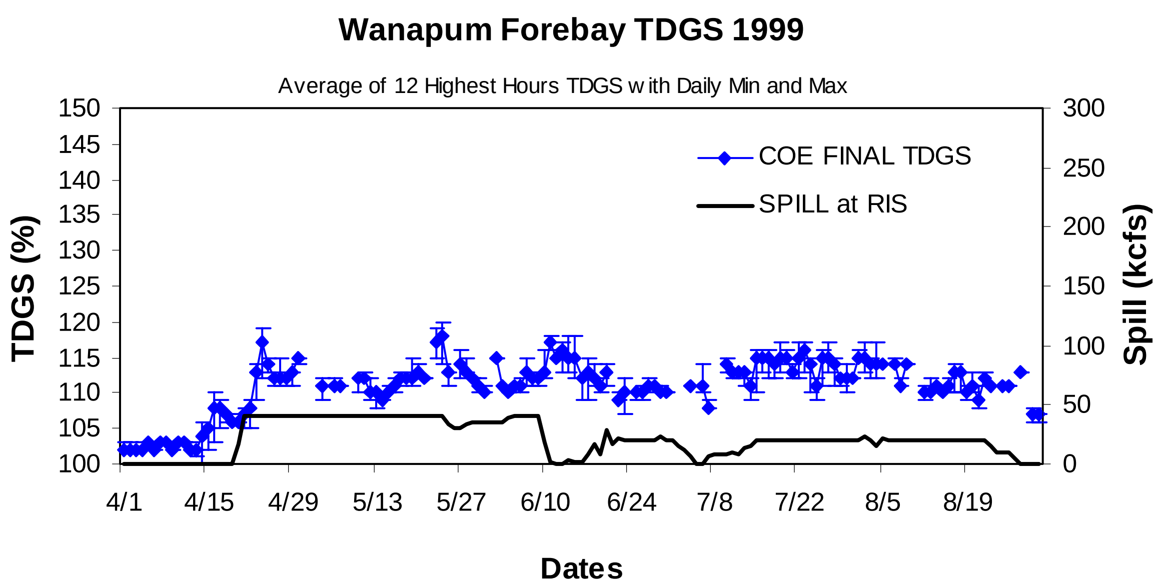

FIGURE B-10. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Wanapum Forebay.

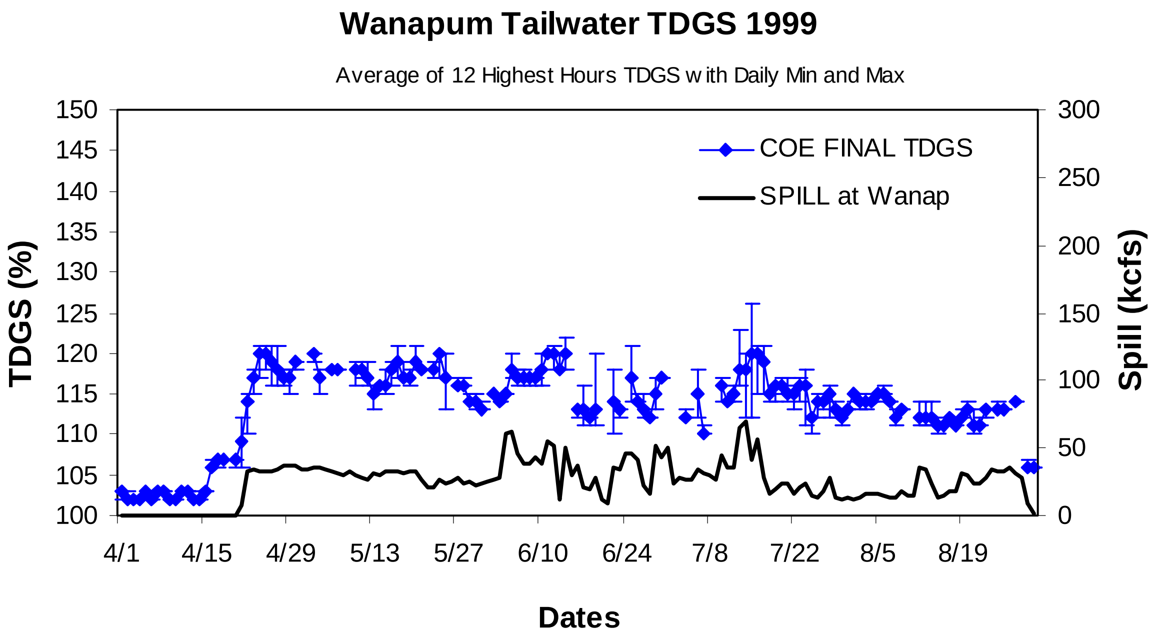

FIGURE B-11. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Wanapum Tailwater.

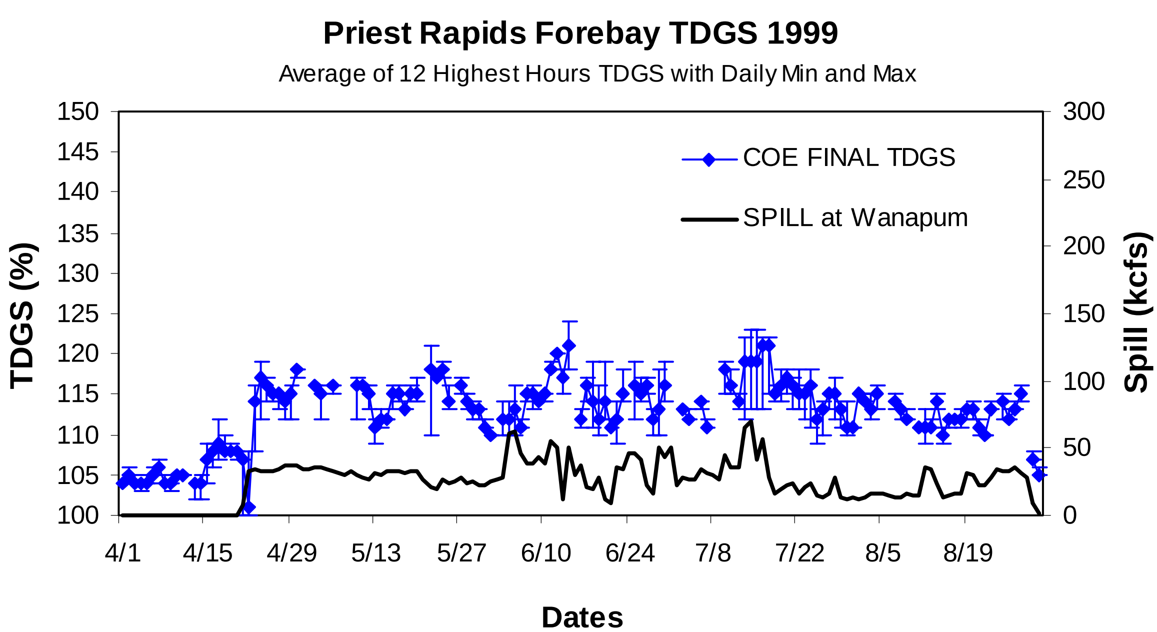

FIGURE B-12. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Priest Rapids Forebay.

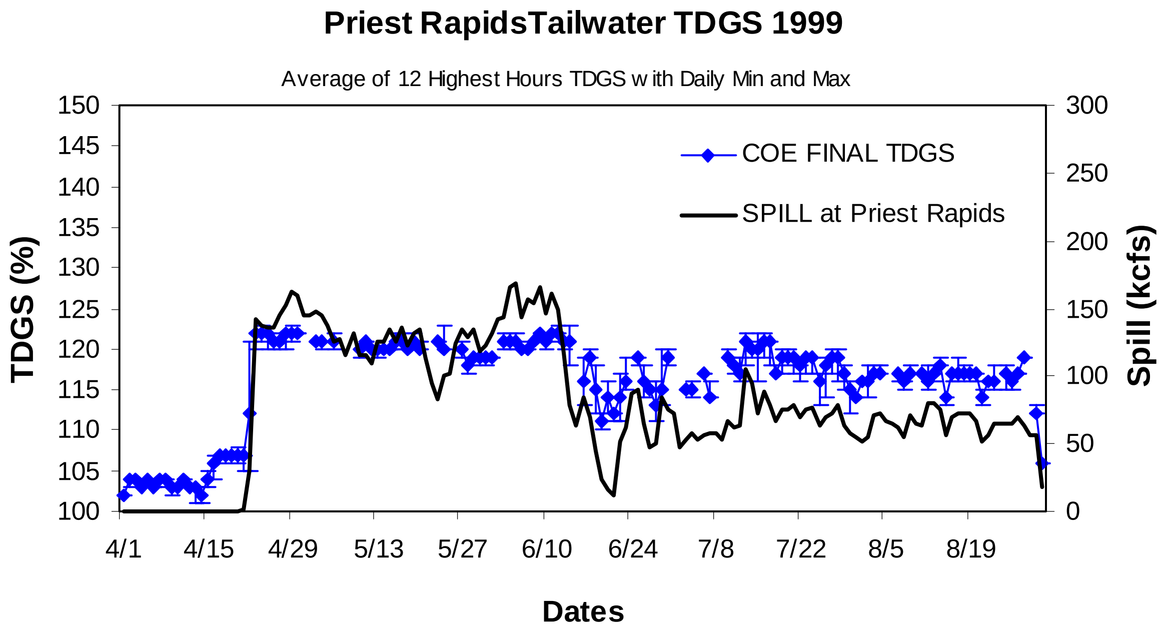

FIGURE B-13. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Priest Rapids Tailwater.

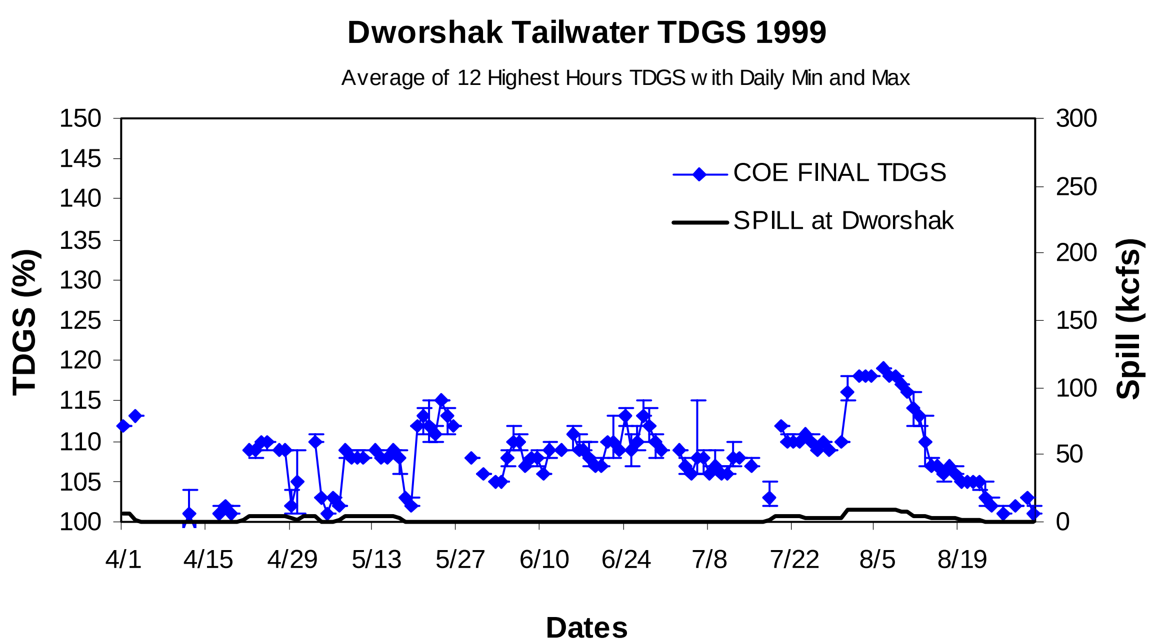

FIGURE B-14. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Dworshak Tailwater.

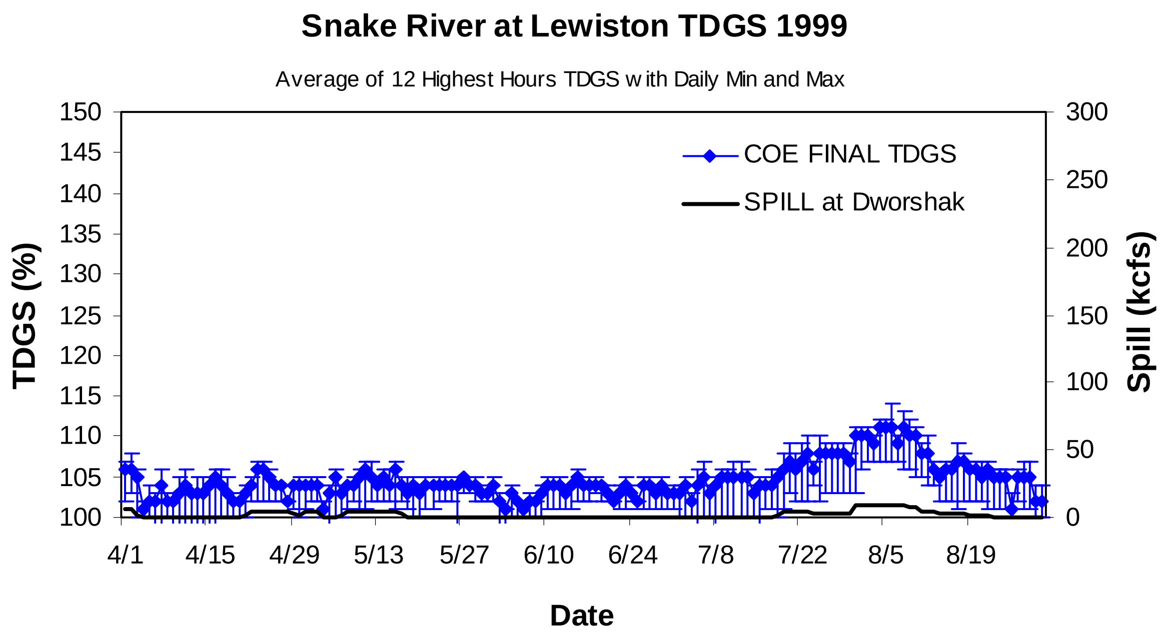

FIGURE B-15. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at the Snake River at Lewiston.

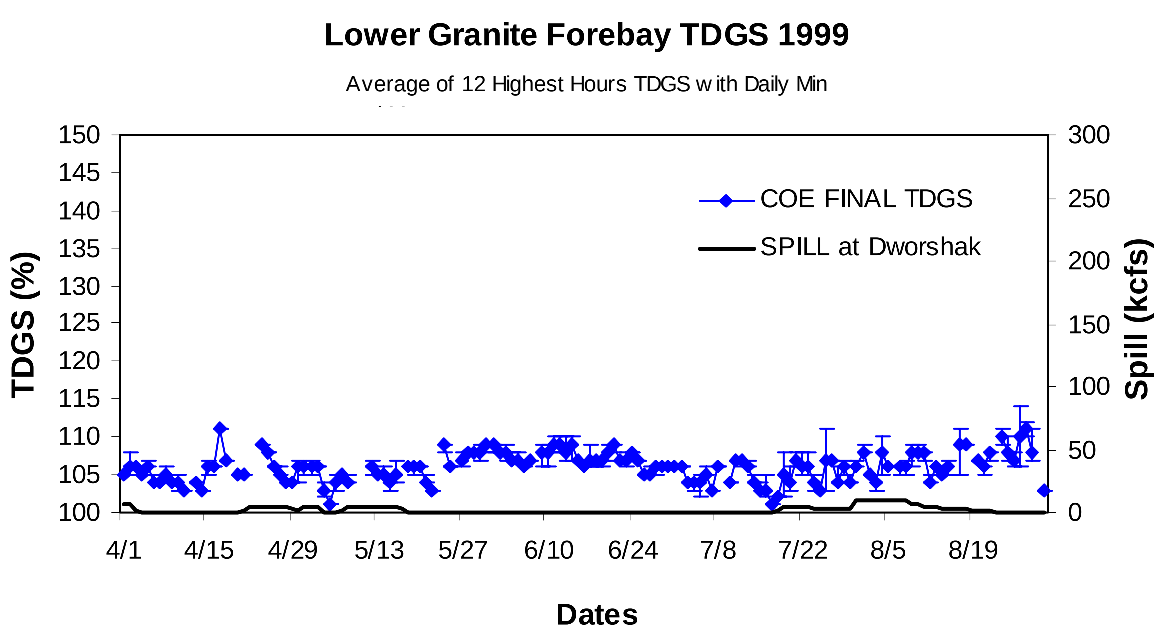

FIGURE B-16. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Lower Granite Forebay.

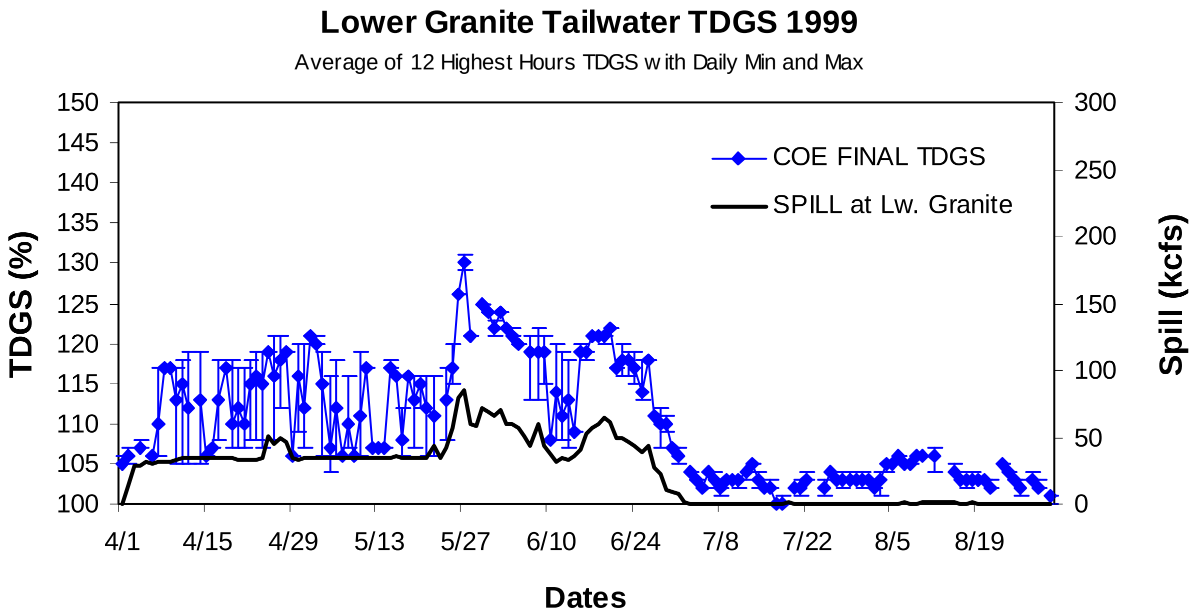

FIGURE B-17. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Lower Granite Tailwater.

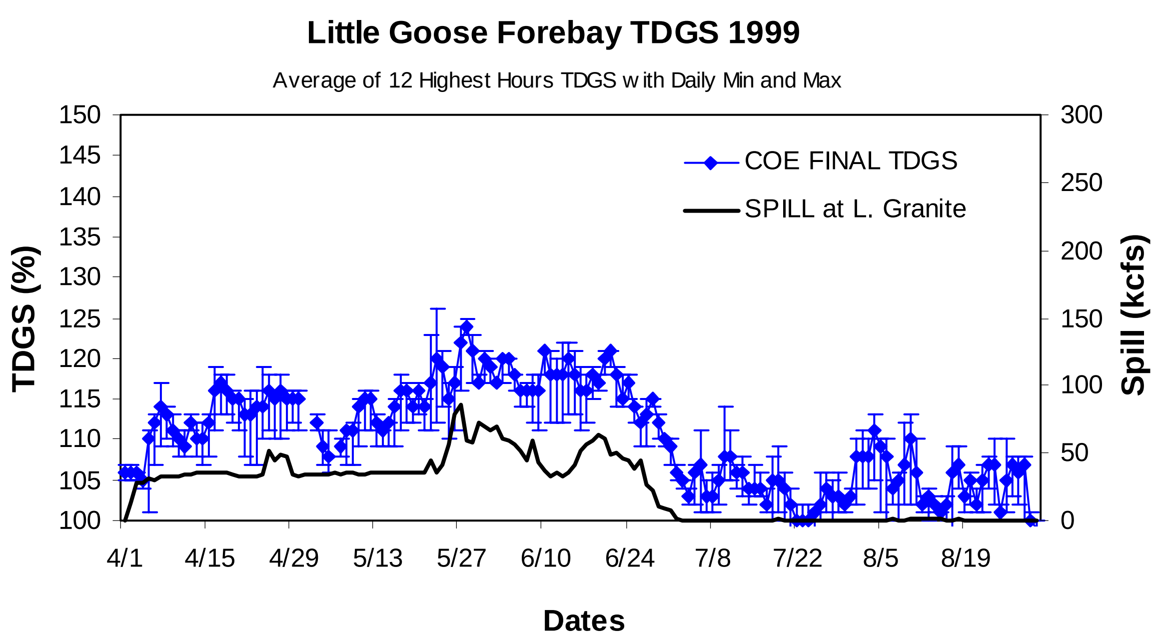

FIGURE B-18. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Little Goose Forebay.

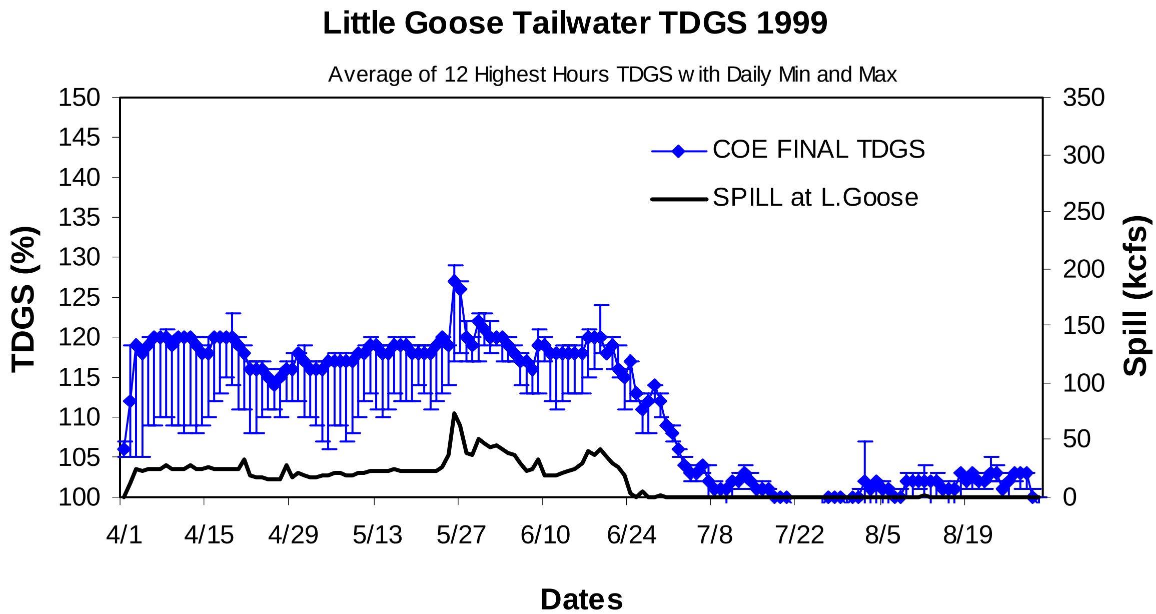

FIGURE B-19. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Little Goose Tailwater.

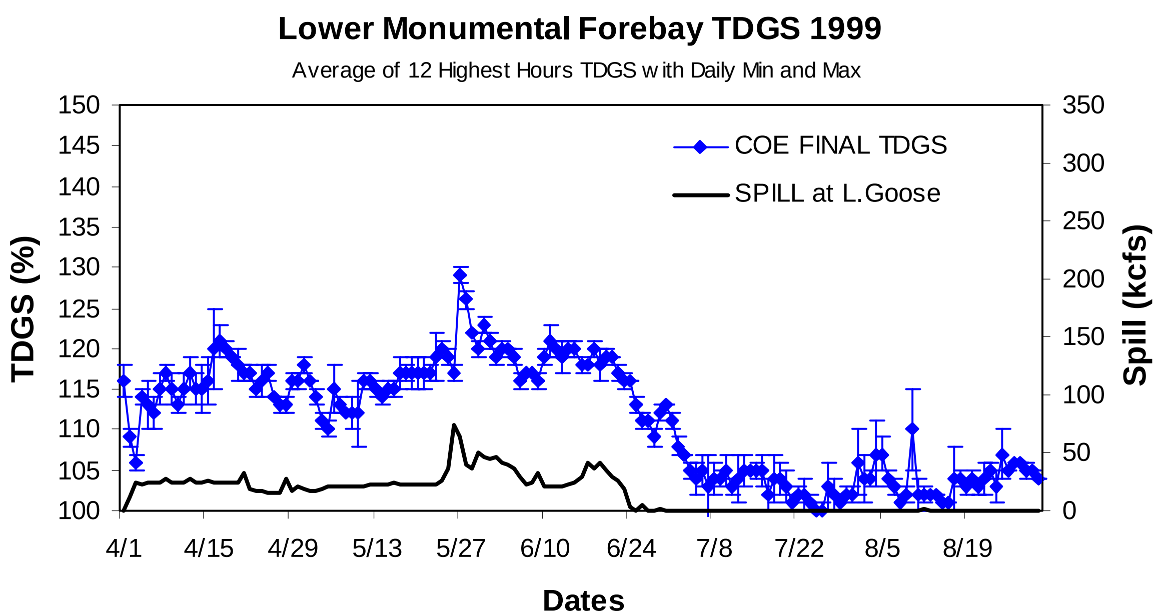

FIGURE B-20. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Lower Monumental Forebay.

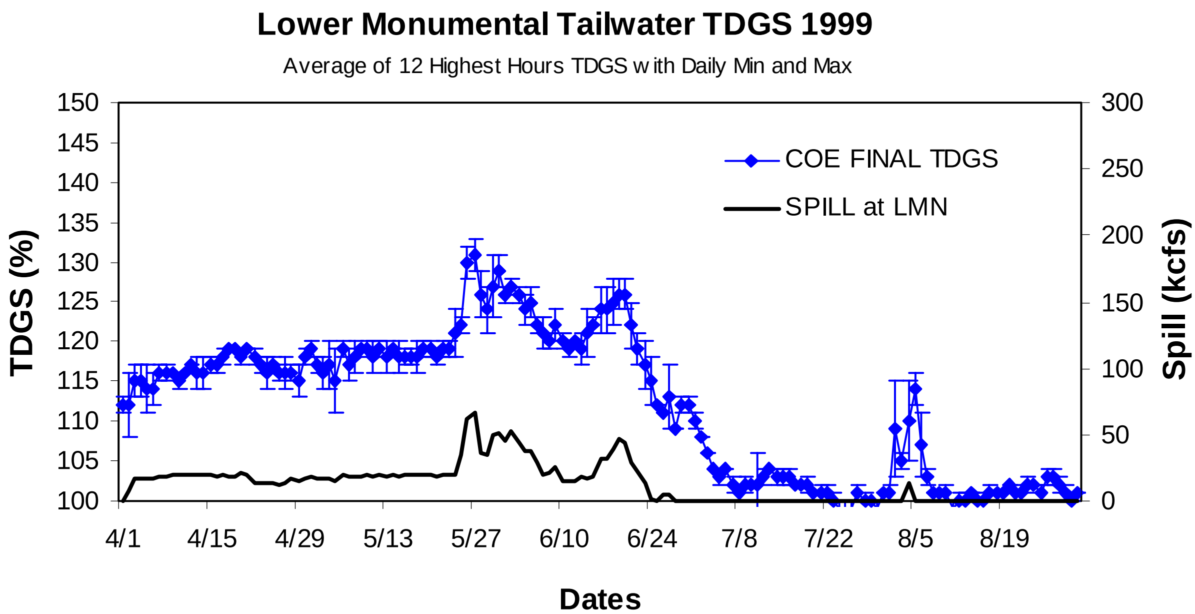

FIGURE B-21. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Lower Monumental Tailwater.

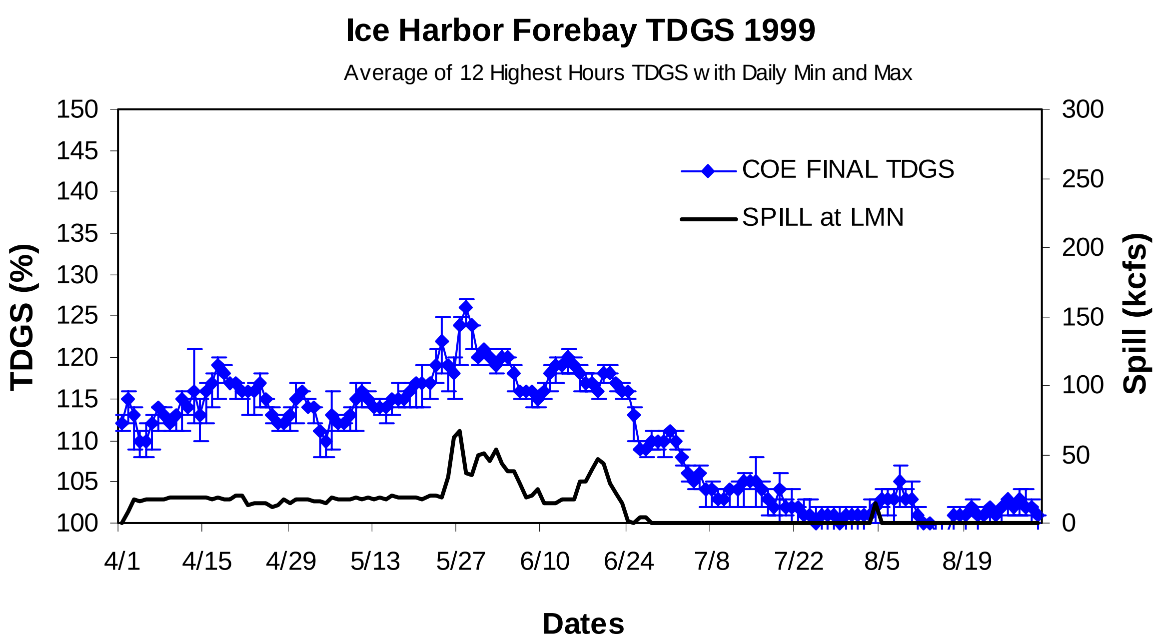

FIGURE B-22. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Ice Harbor Forebay.

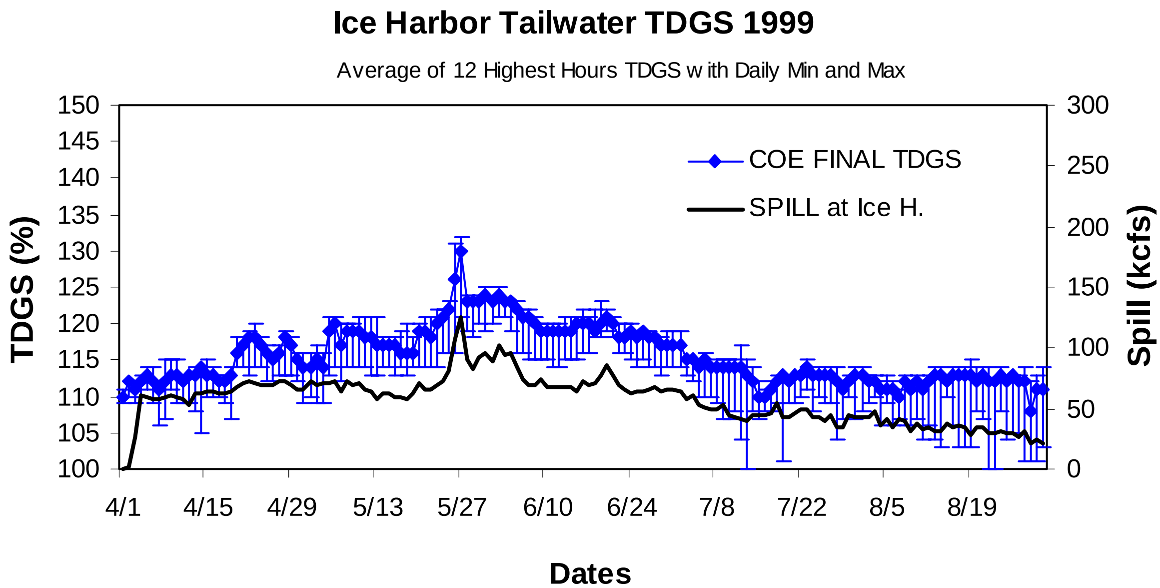

FIGURE B-23. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Ice Harbor Tailwater.

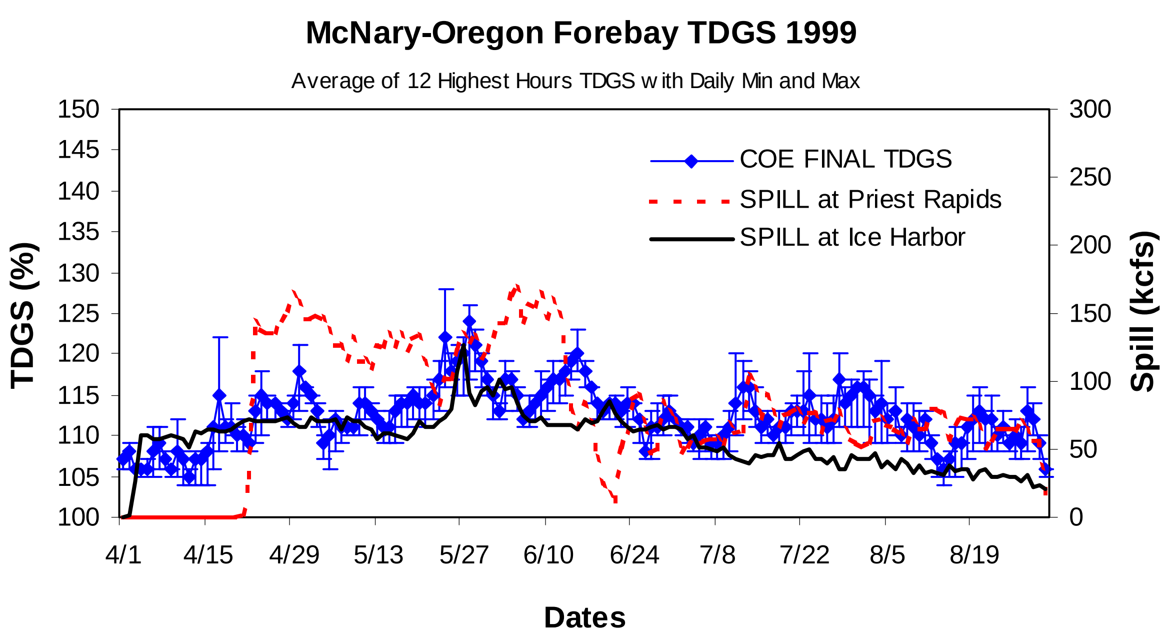

FIGURE B-24. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at McNary-Oregon Forebay.

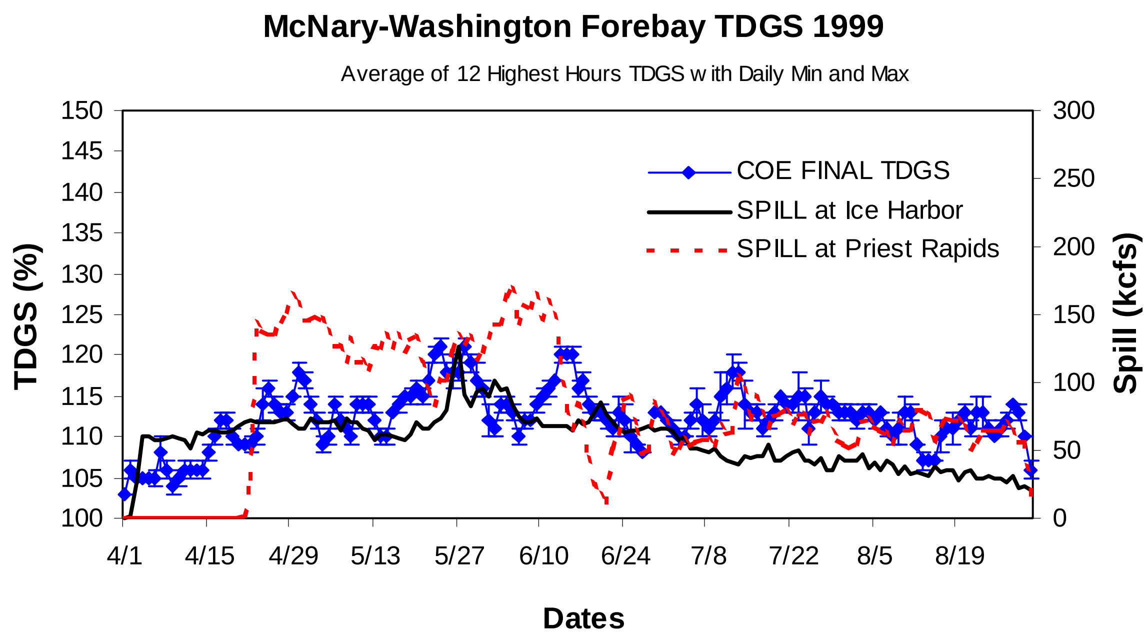

FIGURE B-25. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at McNary-Washington Forebay.

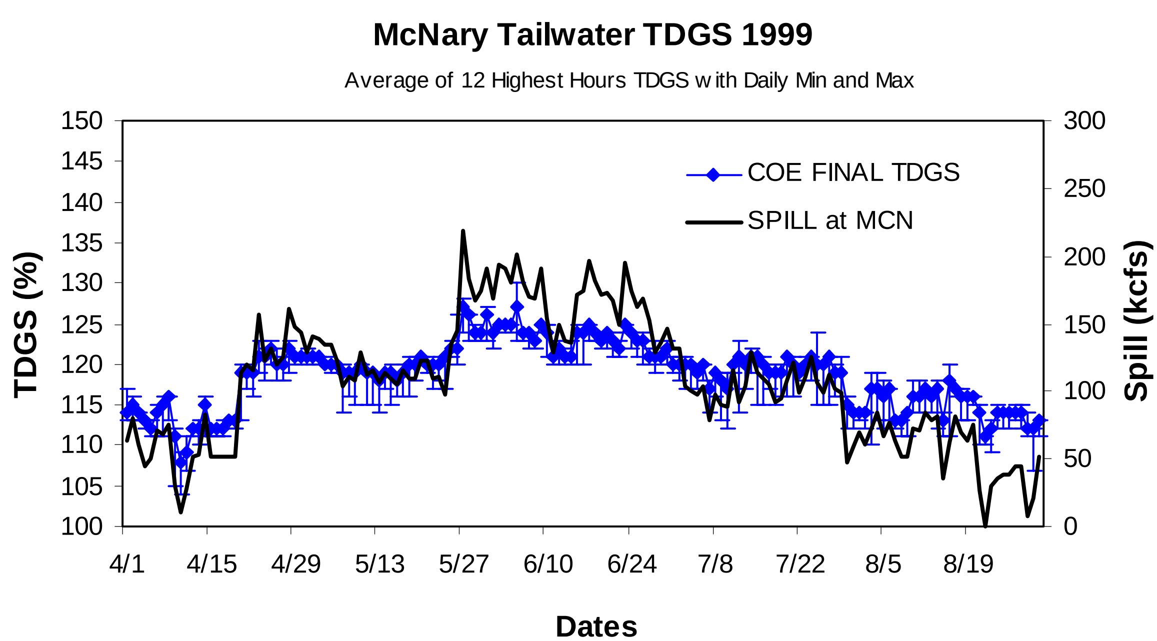

FIGURE B-26. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at McNary Tailwater.

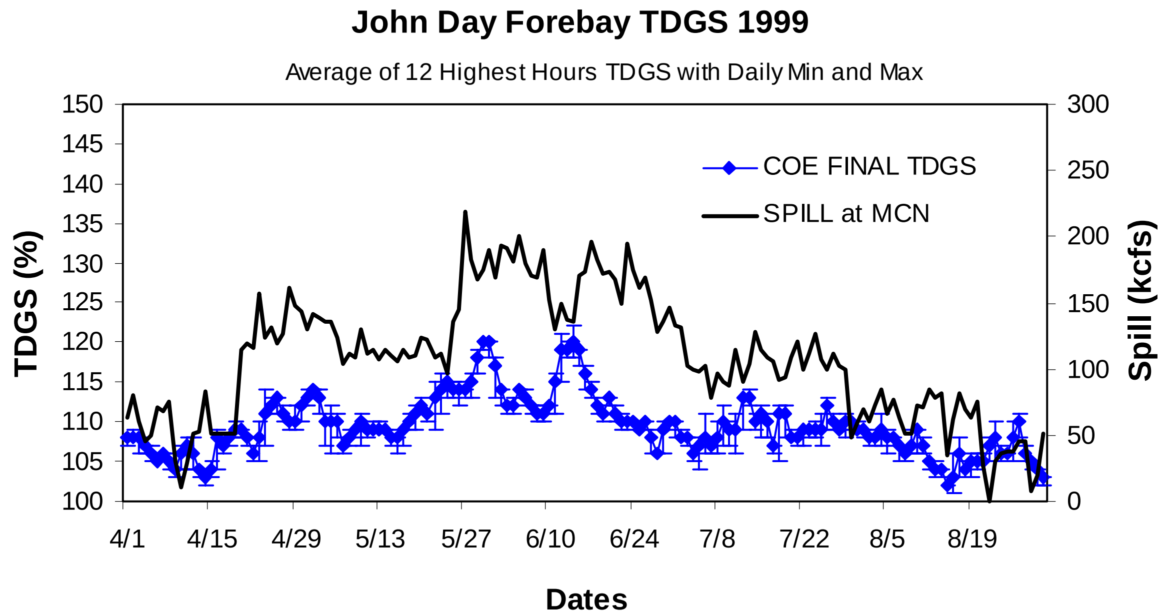

FIGURE B-27. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at John Day Forebay.

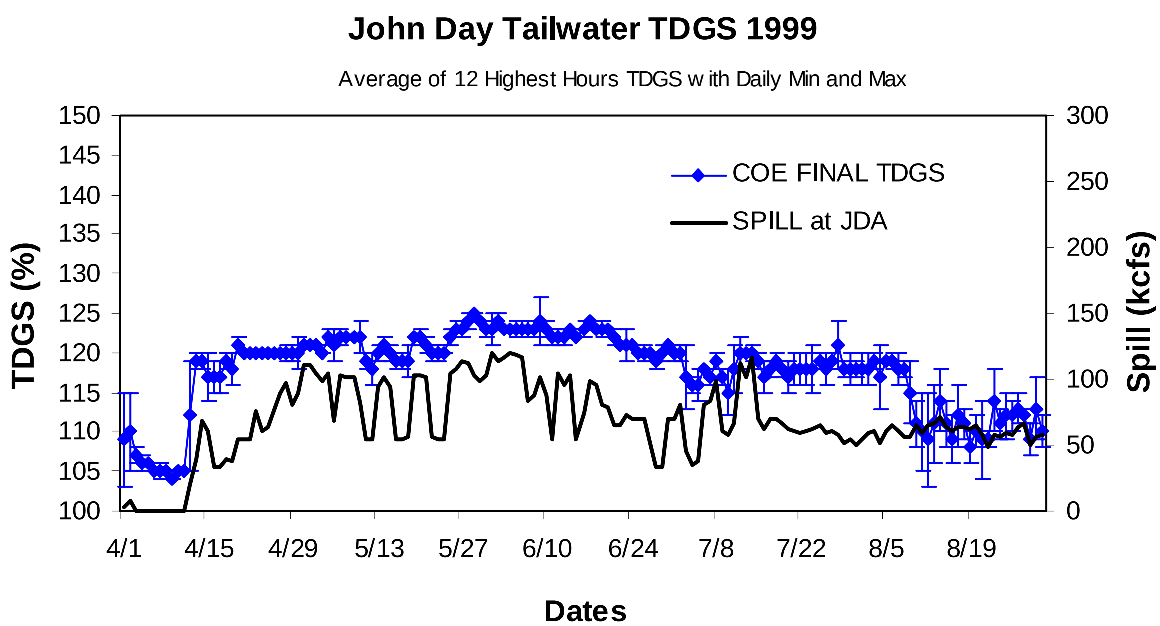

FIGURE B-28. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at John Day Tailwater.

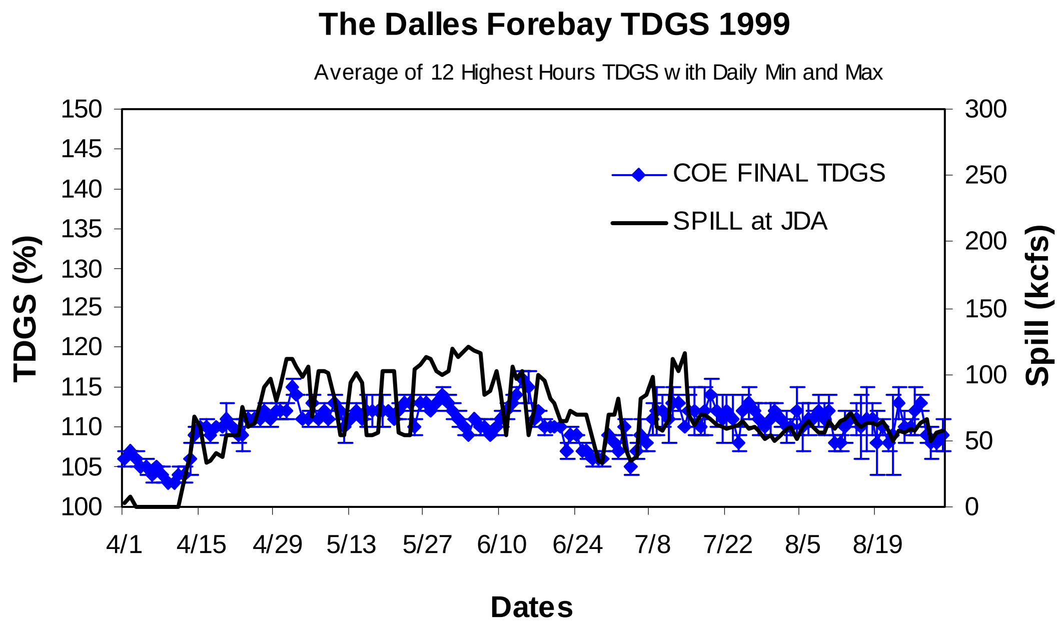

FIGURE B-29. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at The Dalles Forebay.

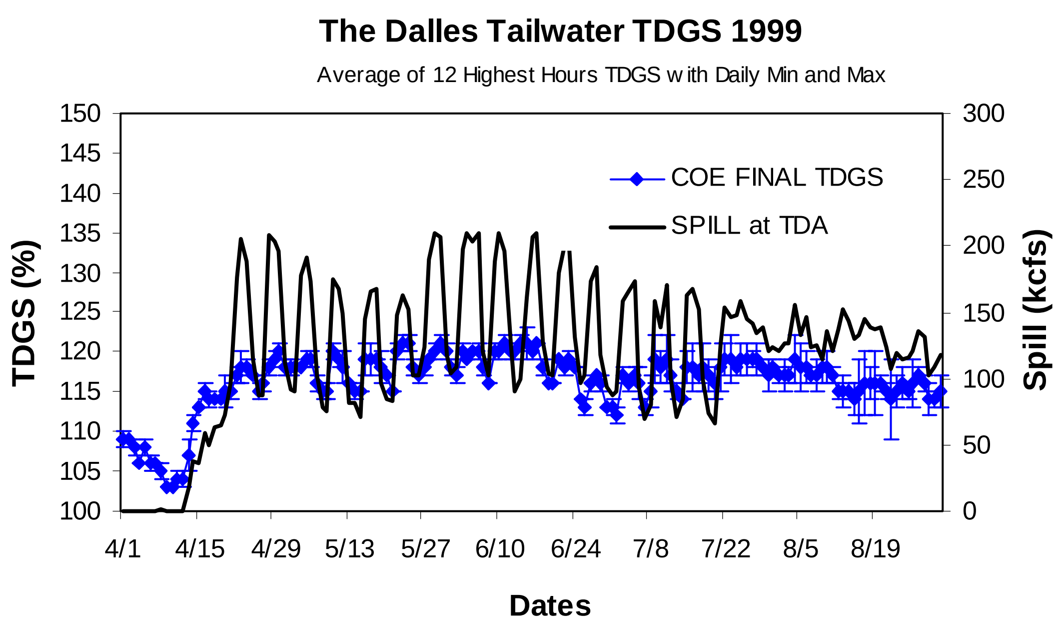

FIGURE B-30. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at The Dalles Tailwater.

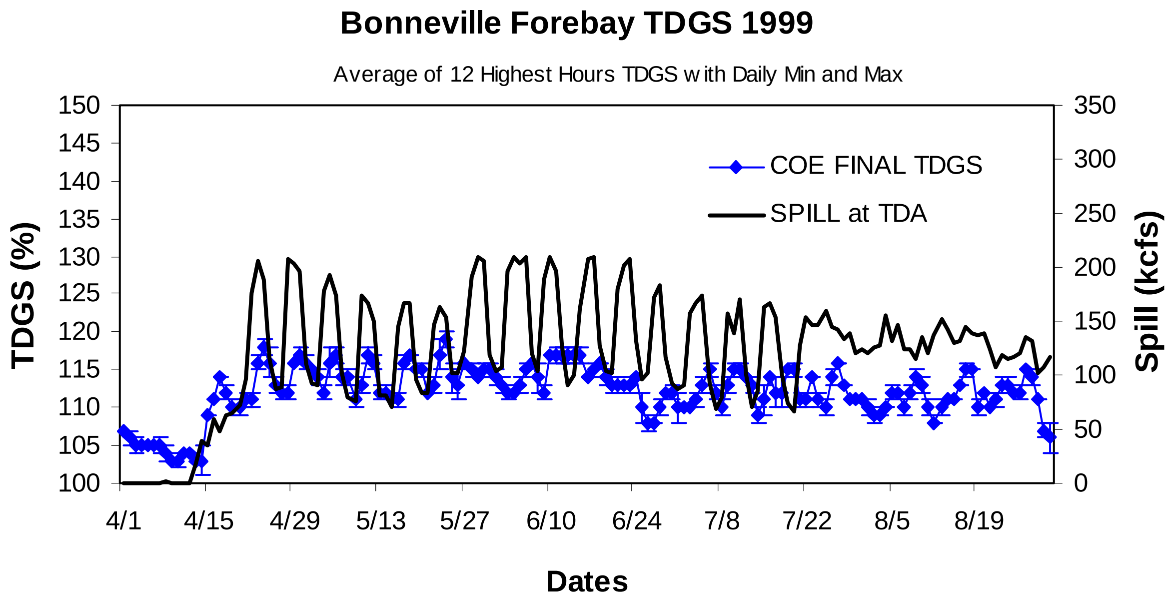

FIGURE B-31. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Bonneville Forebay.

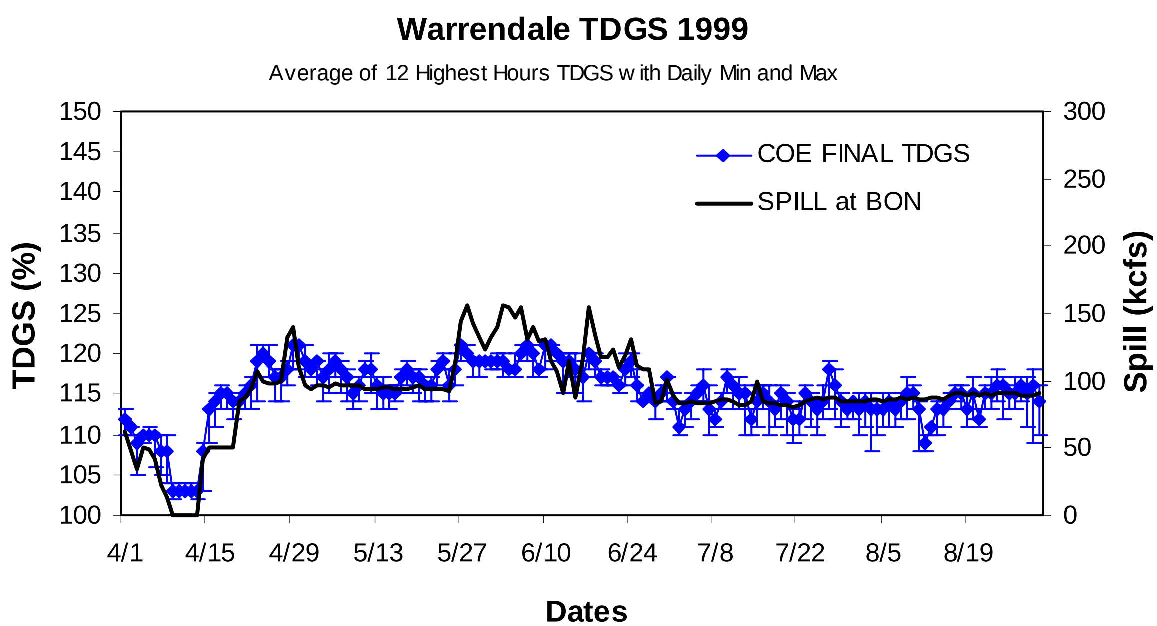

FIGURE B-32. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Warrendale.

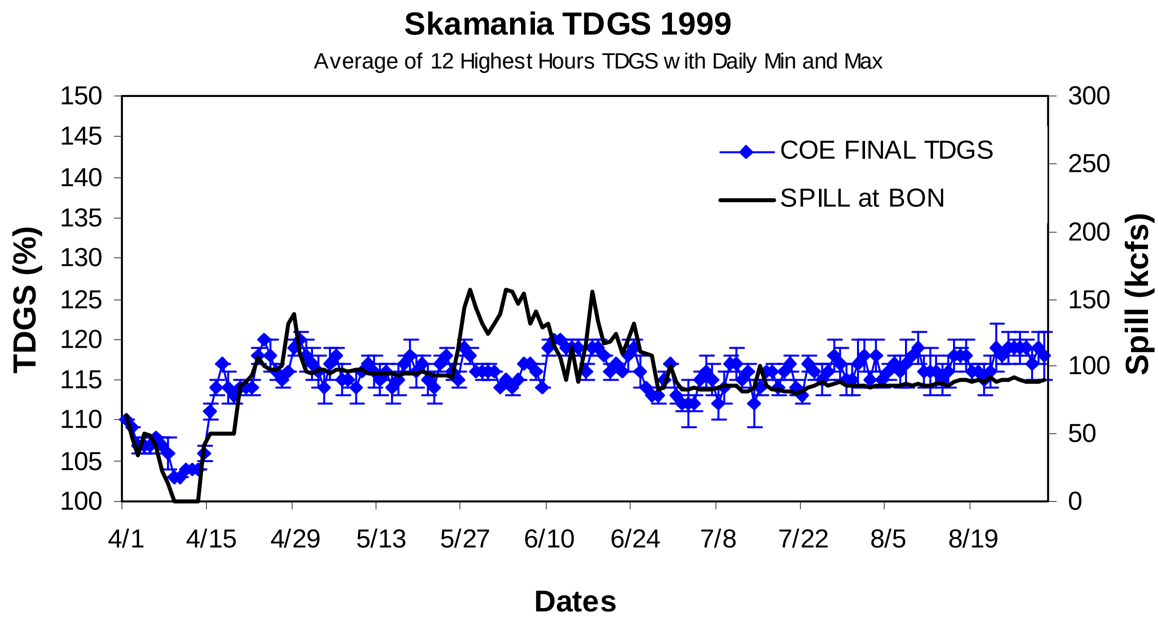

FIGURE B-33. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Skamania.

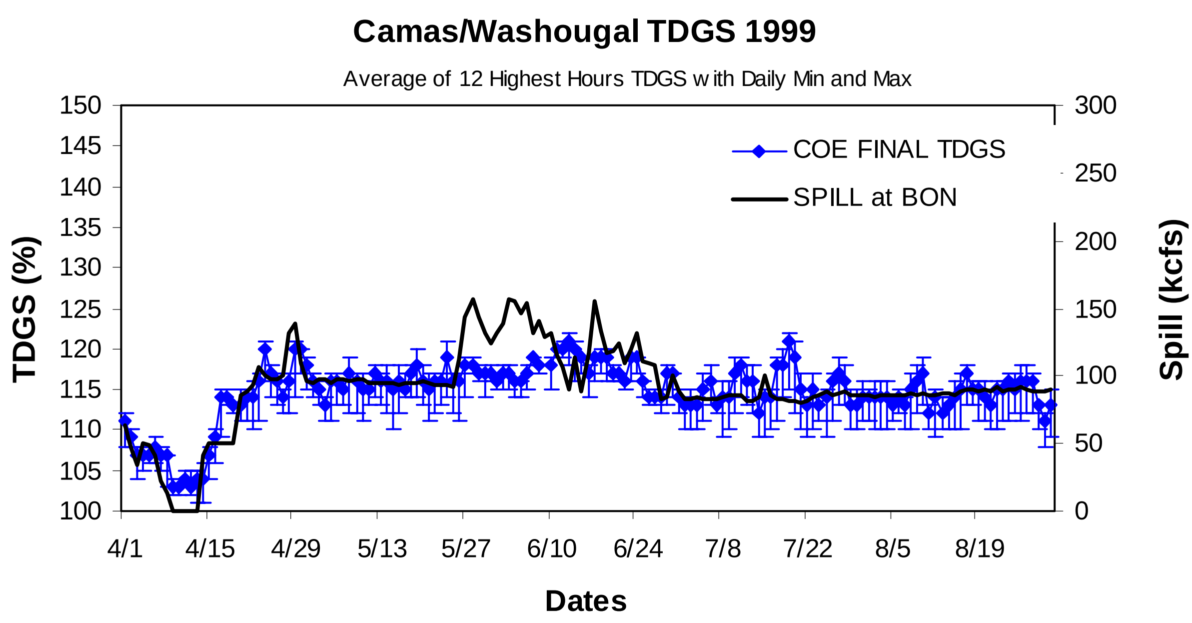

FIGURE B-34. Comparison of the daily average of the 12 highest hourly TDGS readings as reported by FPC from CROHMS data (FPC TDGS) and as computed from COE final database (COE TDGS) at Camas/Washougal.

APPENDIX C

Gas Bubble Trauma and

Total Dissolved Gas Saturation

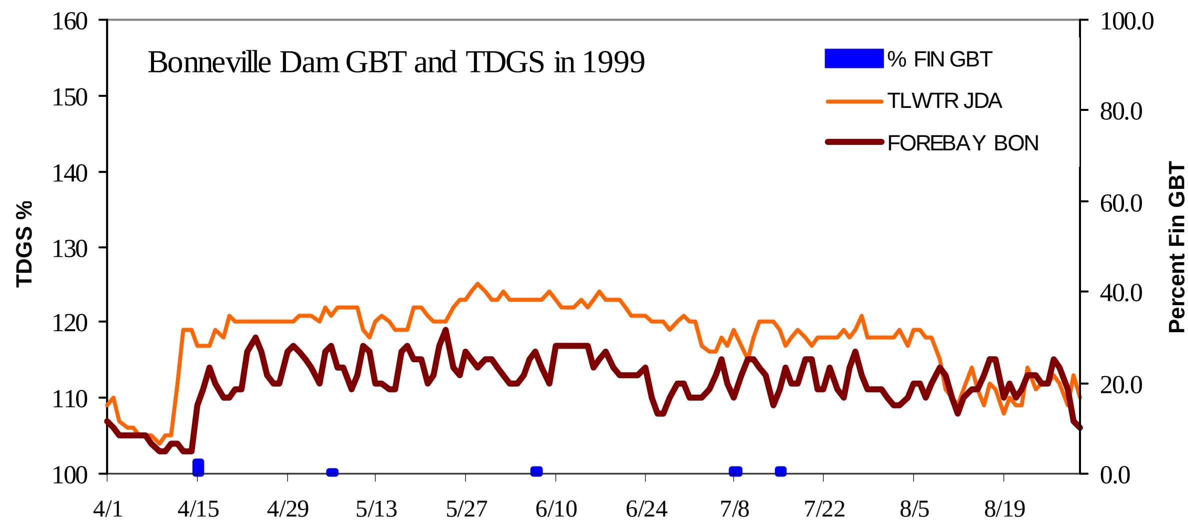

FIGURE C-1. Percent of fish examined at Bonneville Dam showing signs of GBT with associated dissolved gas saturation levels in the Bonneville Dam forebay and the John Day Dam tailwater.

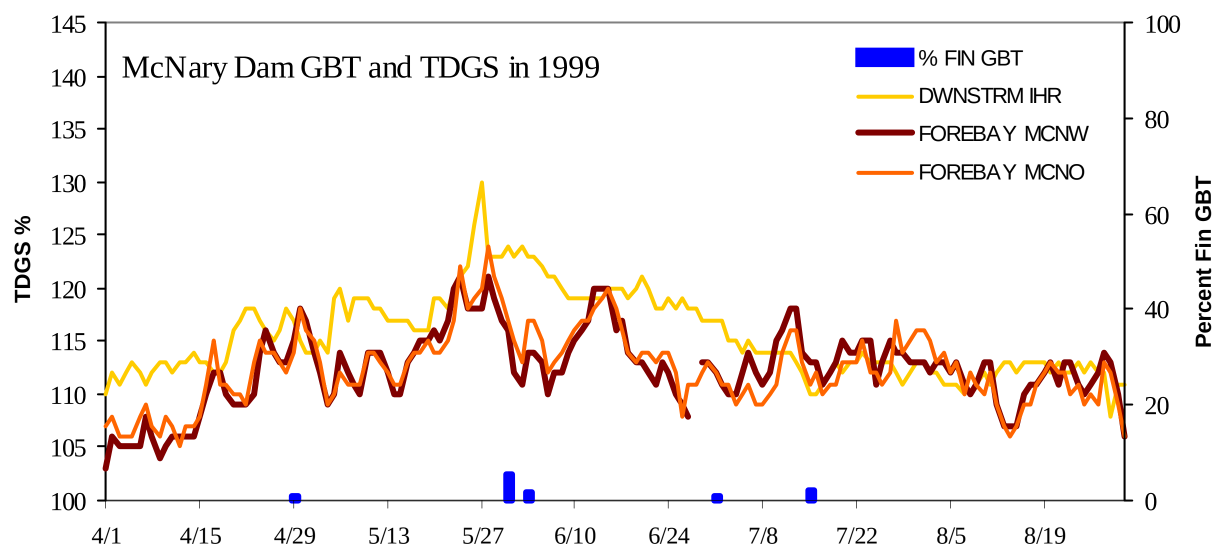

FIGURE C-2. Percent of fish examined at McNary Dam showing signs of GBT with associated dissolved gas saturation levels in the McNary Dam forebay (Oregon and Washington sides) and the Ice Harbor Dam tailwater.

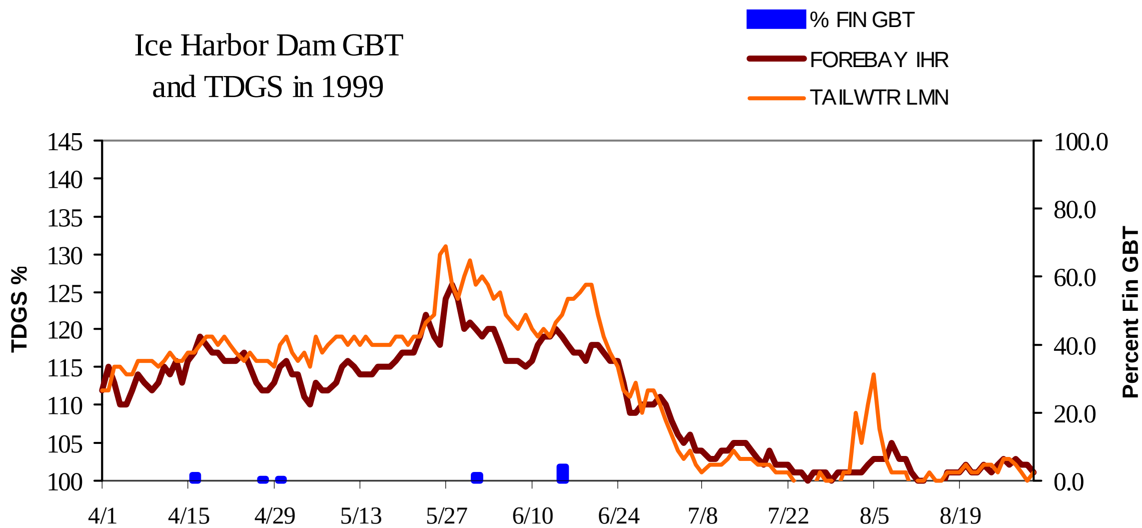

FIGURE C-3. Percent of fish examined at Ice Harbor Dam showing signs of GBT with associated dissolved gas saturation levels in the Ice Harbor Dam forebay and the Lower Monumental Dam tailwater.

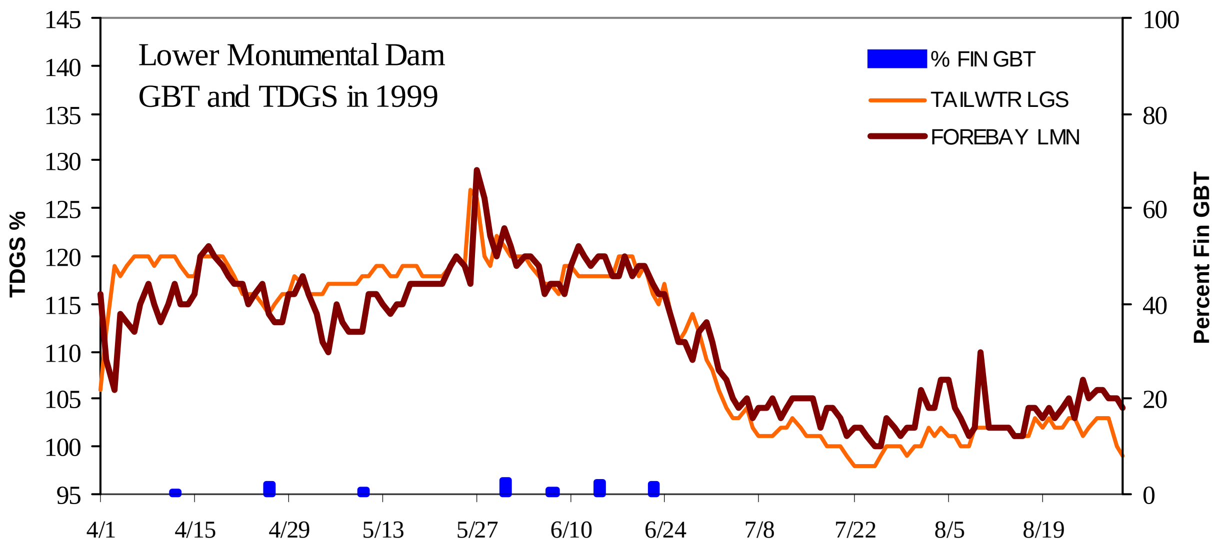

FIGURE C-4. Percent of fish examined at Lower Monumental Dam showing signs of GBT with associated dissolved gas saturation levels in the Lower Monumental Dam forebay and the Little Goose Dam tailwater.

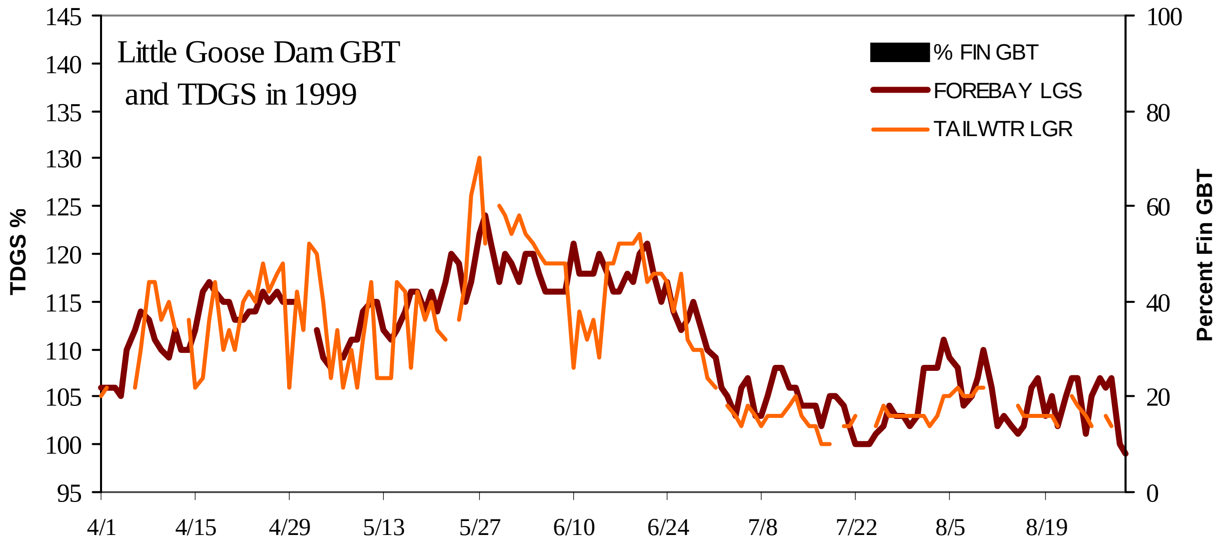

FIGURE C-5. Percent of fish examined at Little Goose Dam showing signs of GBT with associated dissolved gas saturation levels in the Little Goose Dam forebay and the Lower Granite Dam tailwater.

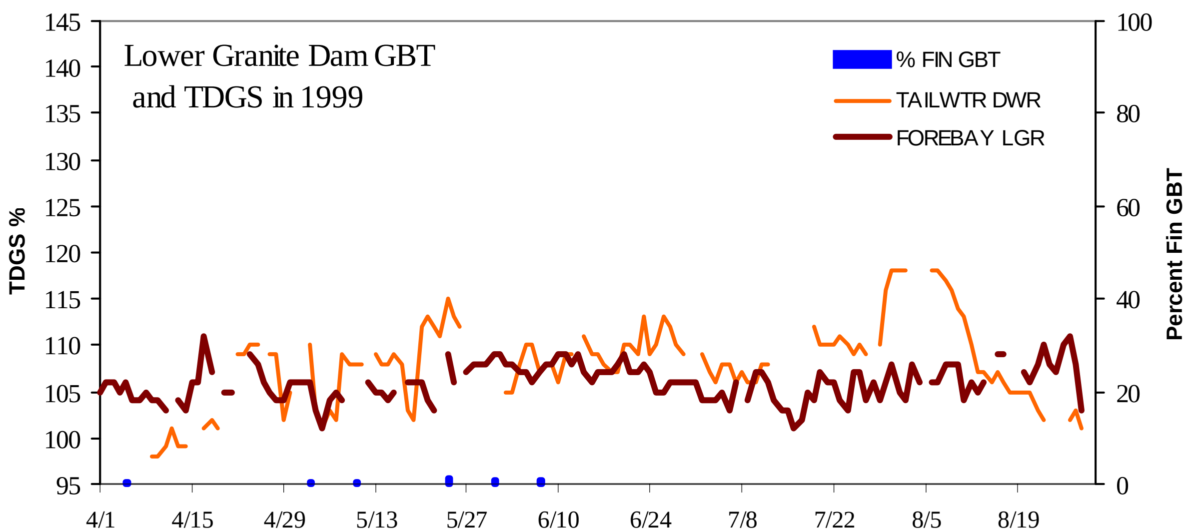

FIGURE C-6. Percent of fish examined at Lower Granite Dam showing signs of GBT with associated dissolved gas saturation levels in the Lower Granite Dam forebay and the Dworshak Dam tailwater.

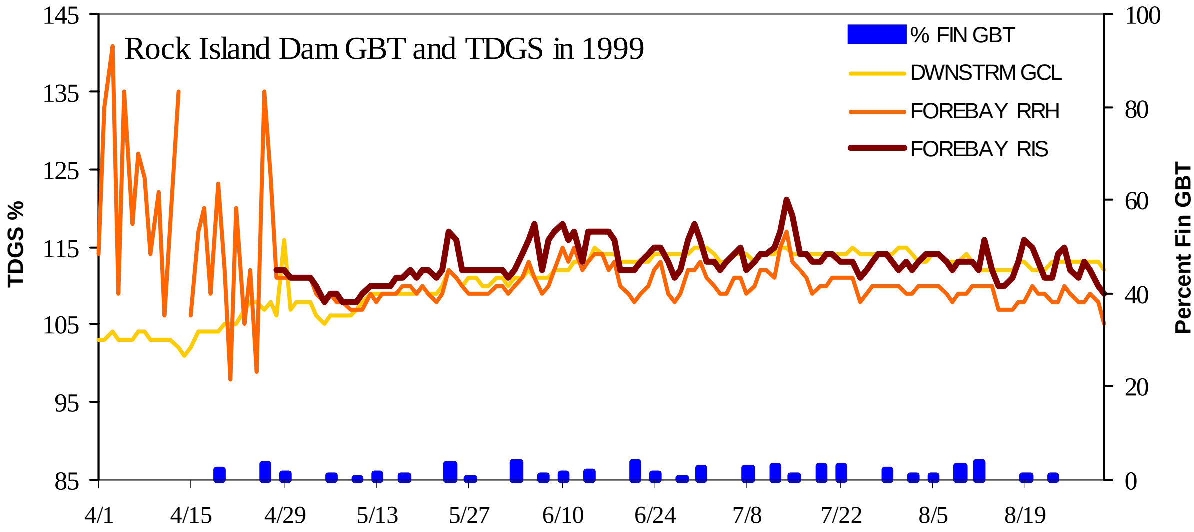

FIGURE C-7. Percent of fish examined at Rock Island Dam showing signs of GBT with associated dissolved gas saturation levels in the Rock Island and Rocky Reach Dam forebays and the Grand Coulee Dam tailwater.

APPENDIX D

Migration Timing Plots

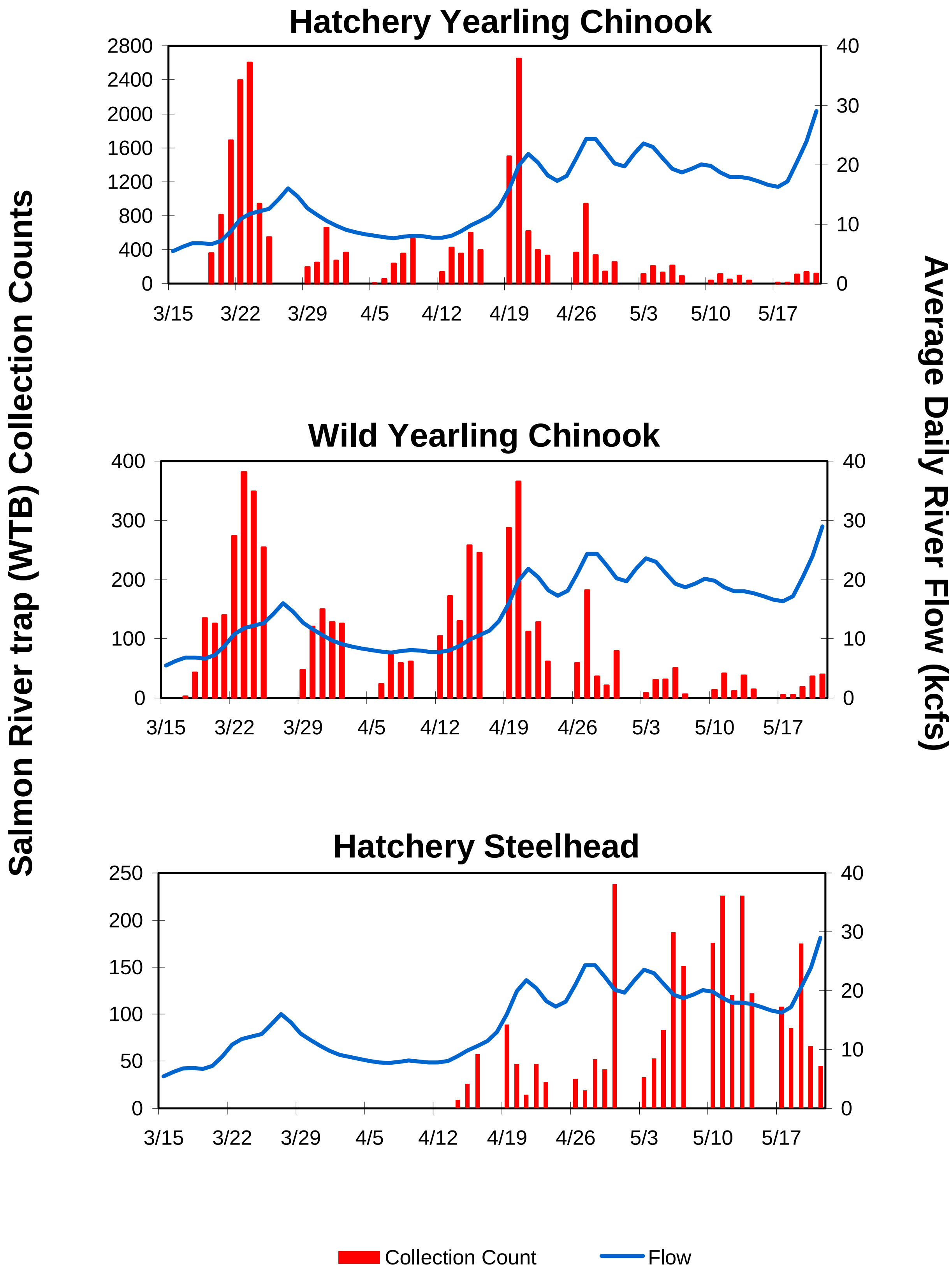

FIGURE D-1. Smolt migration timing at Salmon River Trap (WTB) with associated flow, 1999.

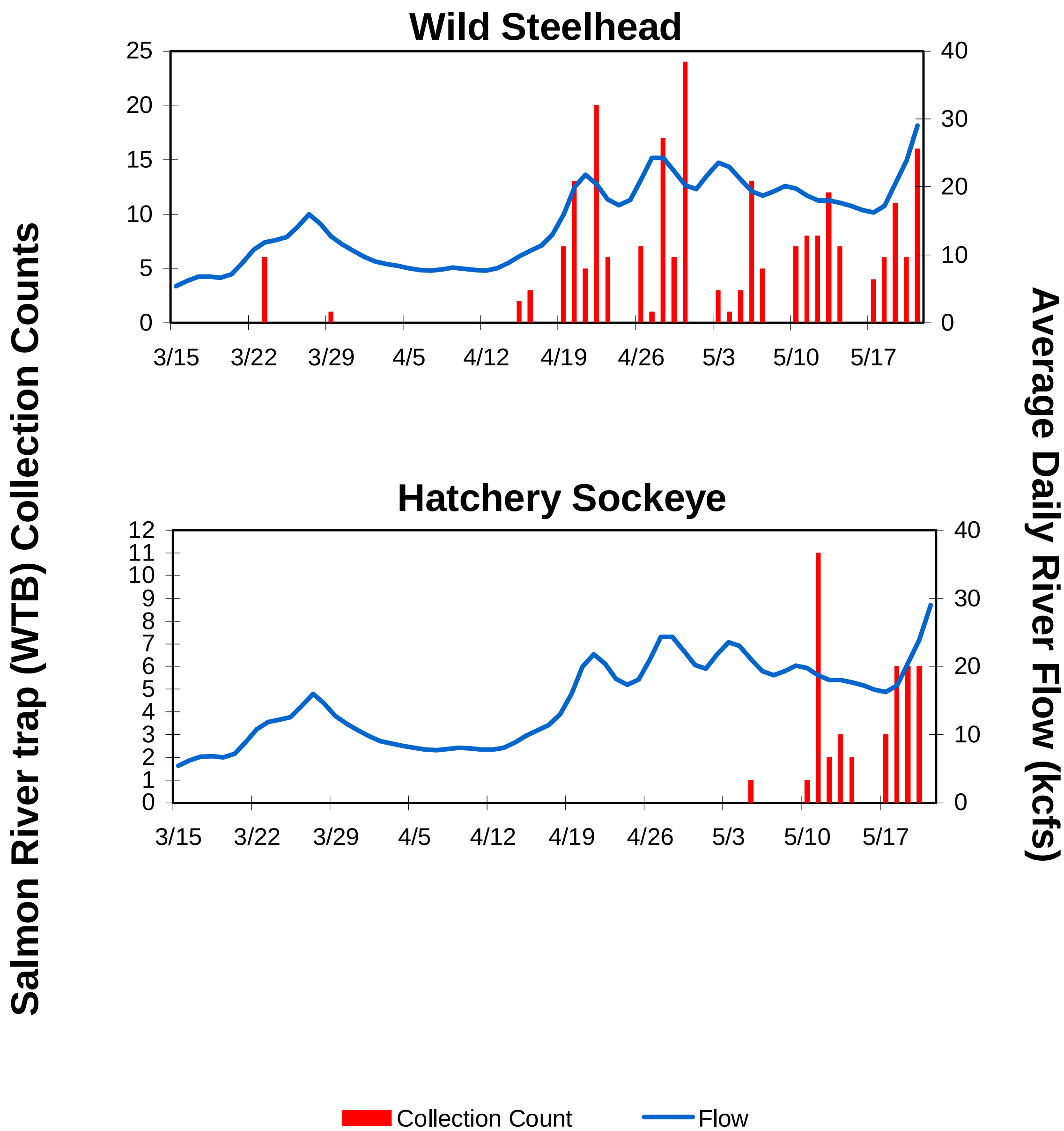

FIGURE D-2. Smolt migration timing at Salmon River Trap (WTB) with associated flow, 1999.

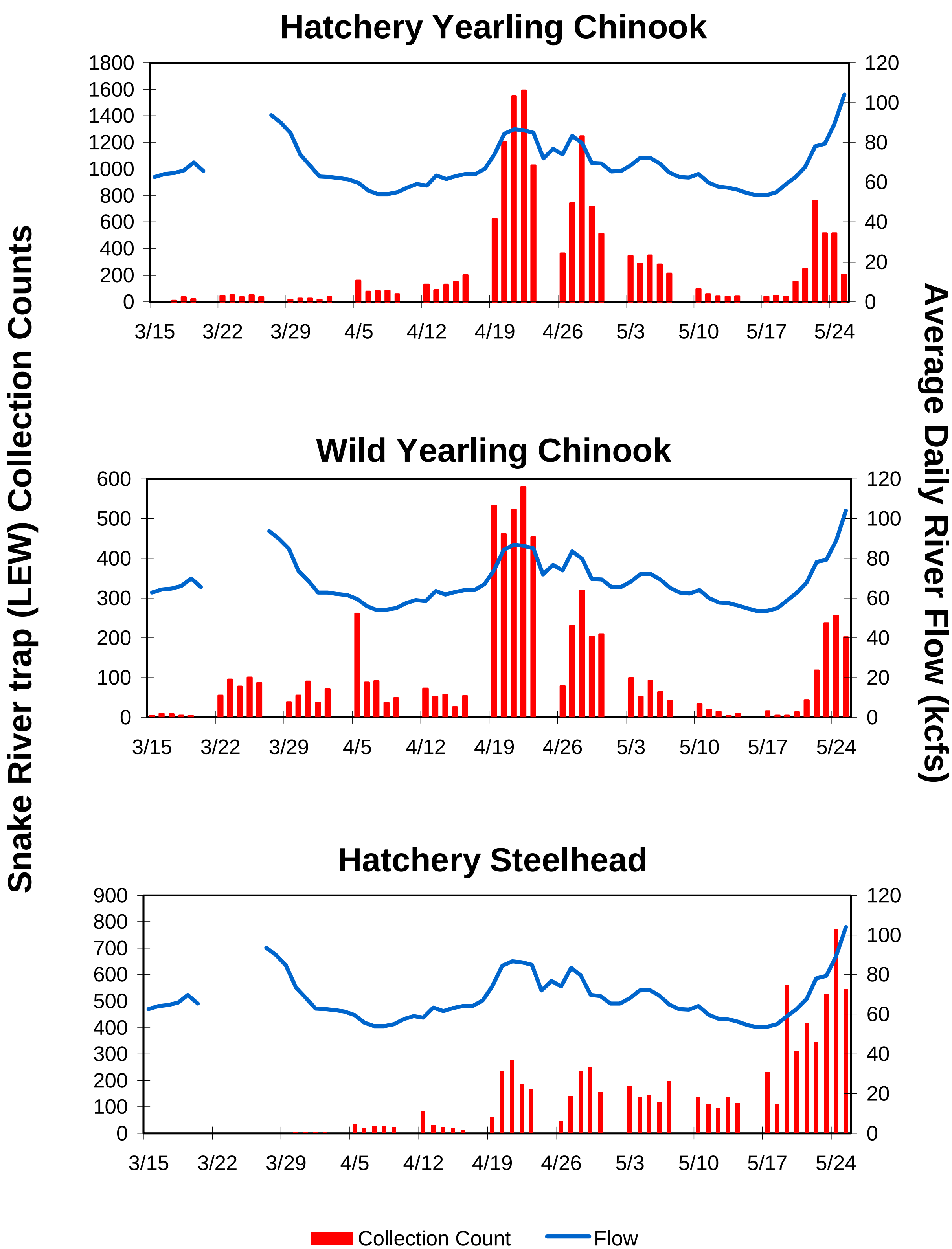

FIGURE D-3. Smolt migration timing at Snake River trap (LEW) with associated flow, 1999.

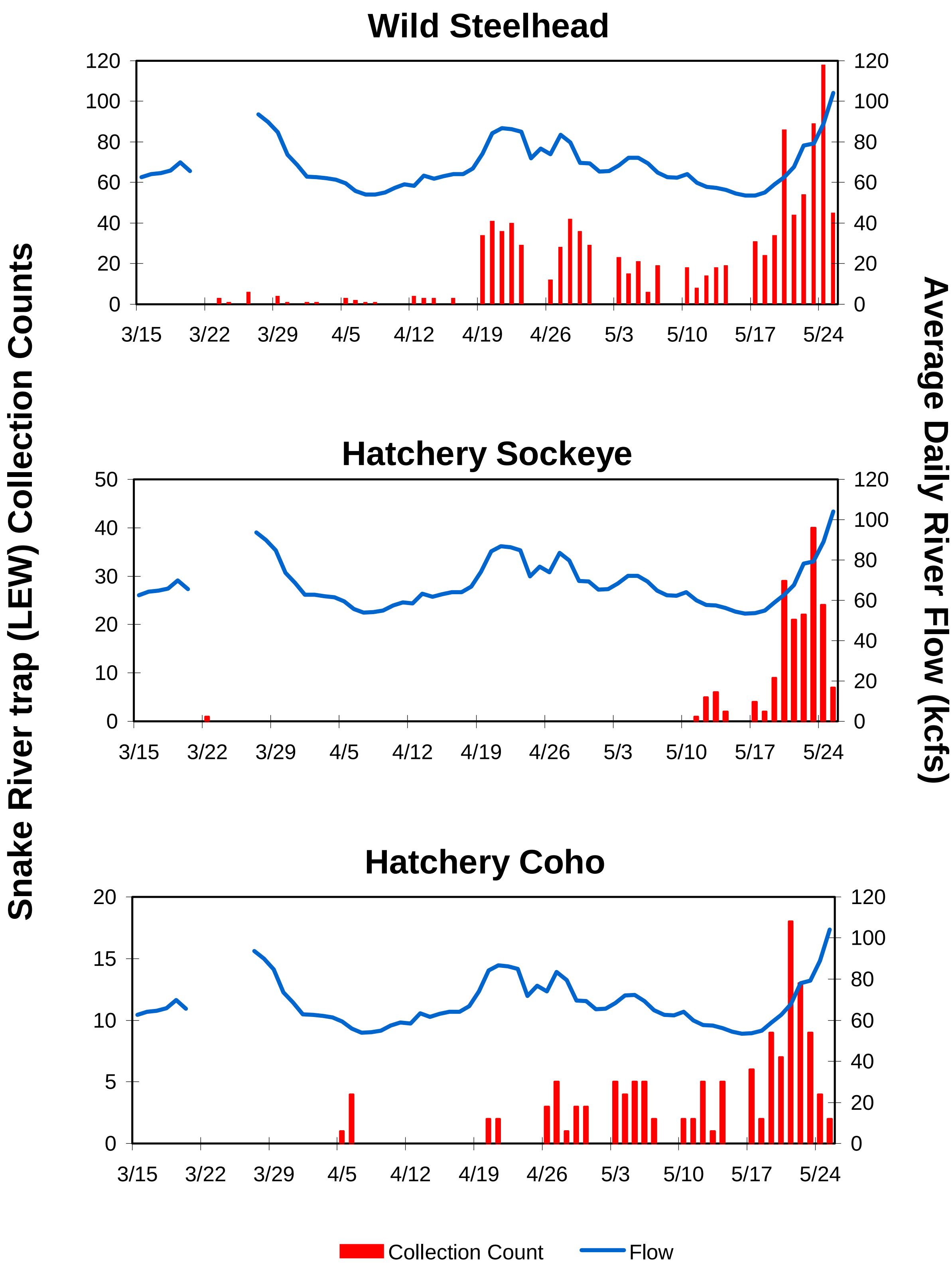

FIGURE D-4. Smolt migration timing at Snake River trap (LEW) and associated flow, 1999.

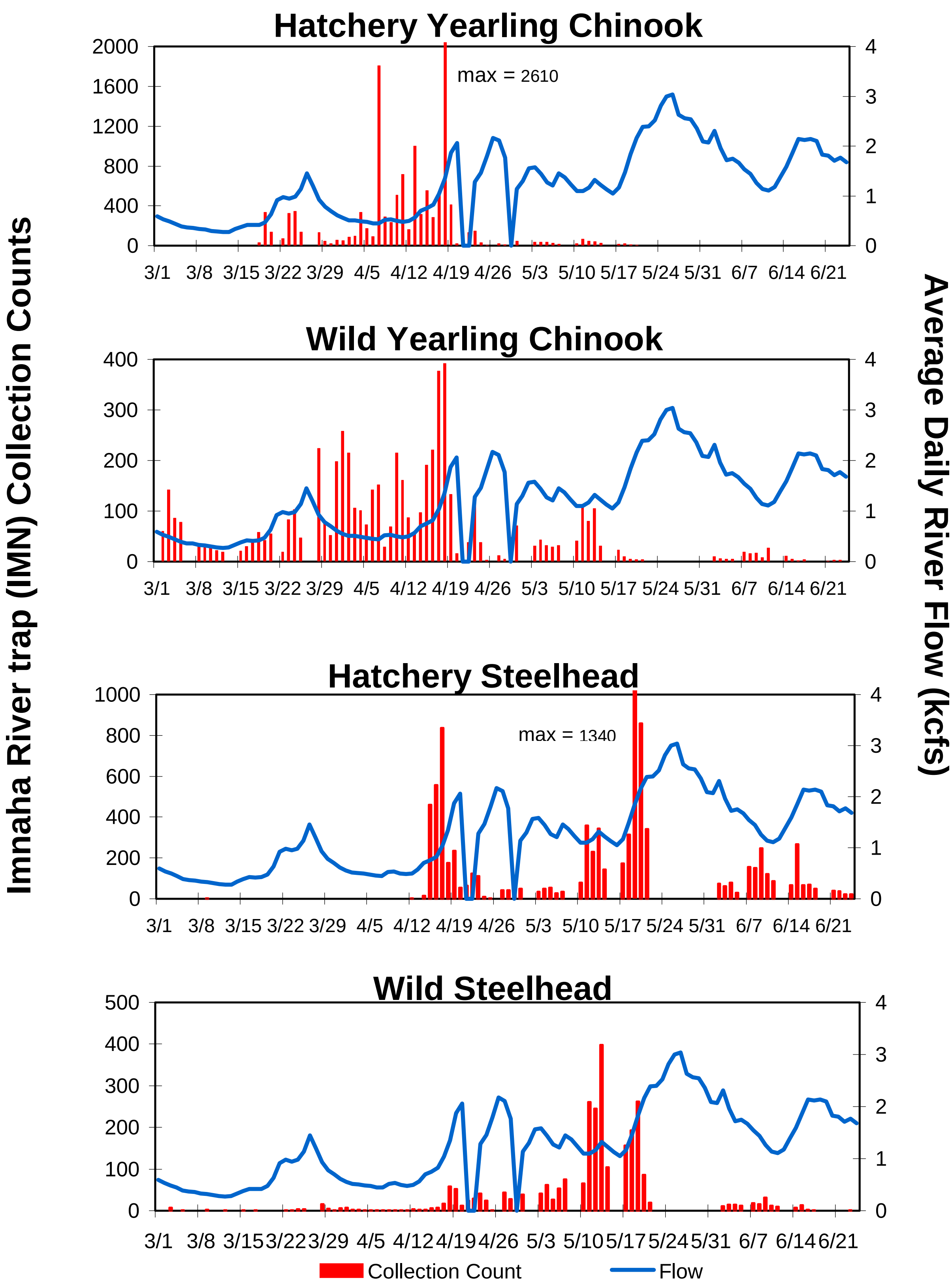

FIGURE D-5. Smolt migration timing at Imnaha River trap with associated flows, 1999.

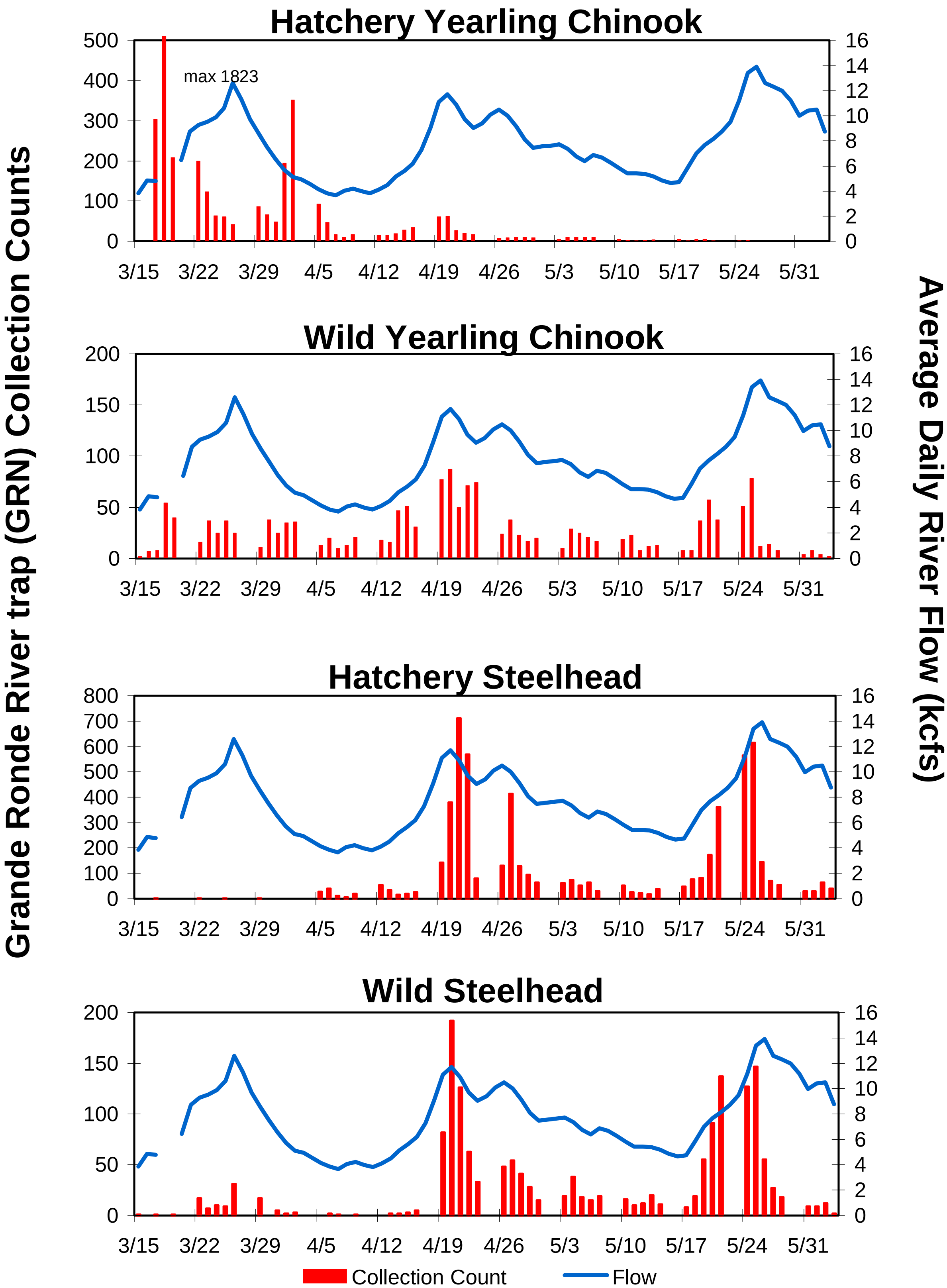

FIGURE D-6. Smolt migration timing at Grande Ronde River Trap with associated flows, 1999.

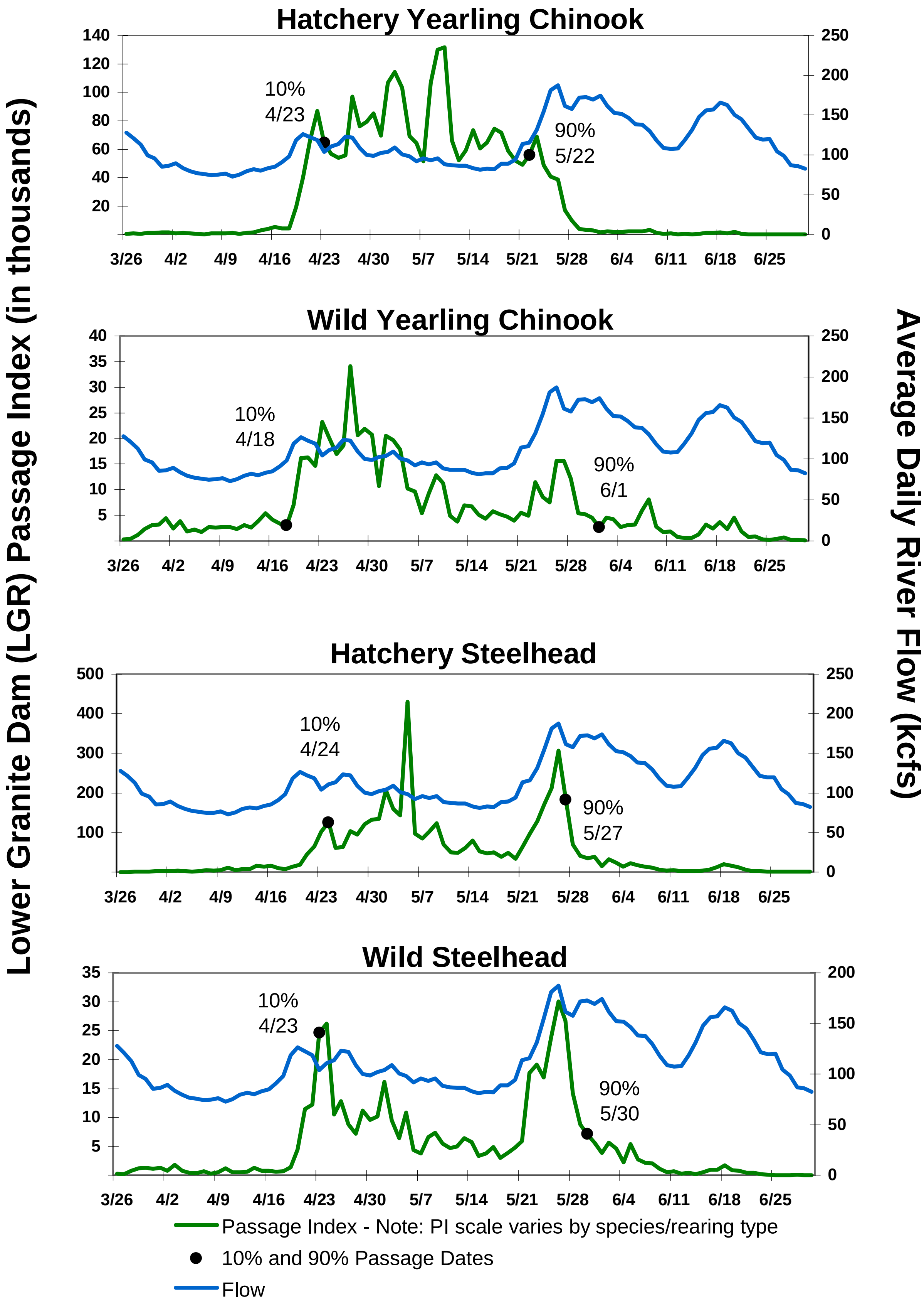

FIGURE D-7. Smolt migration timing at Lower Granite Dam with associated flow, 1999.

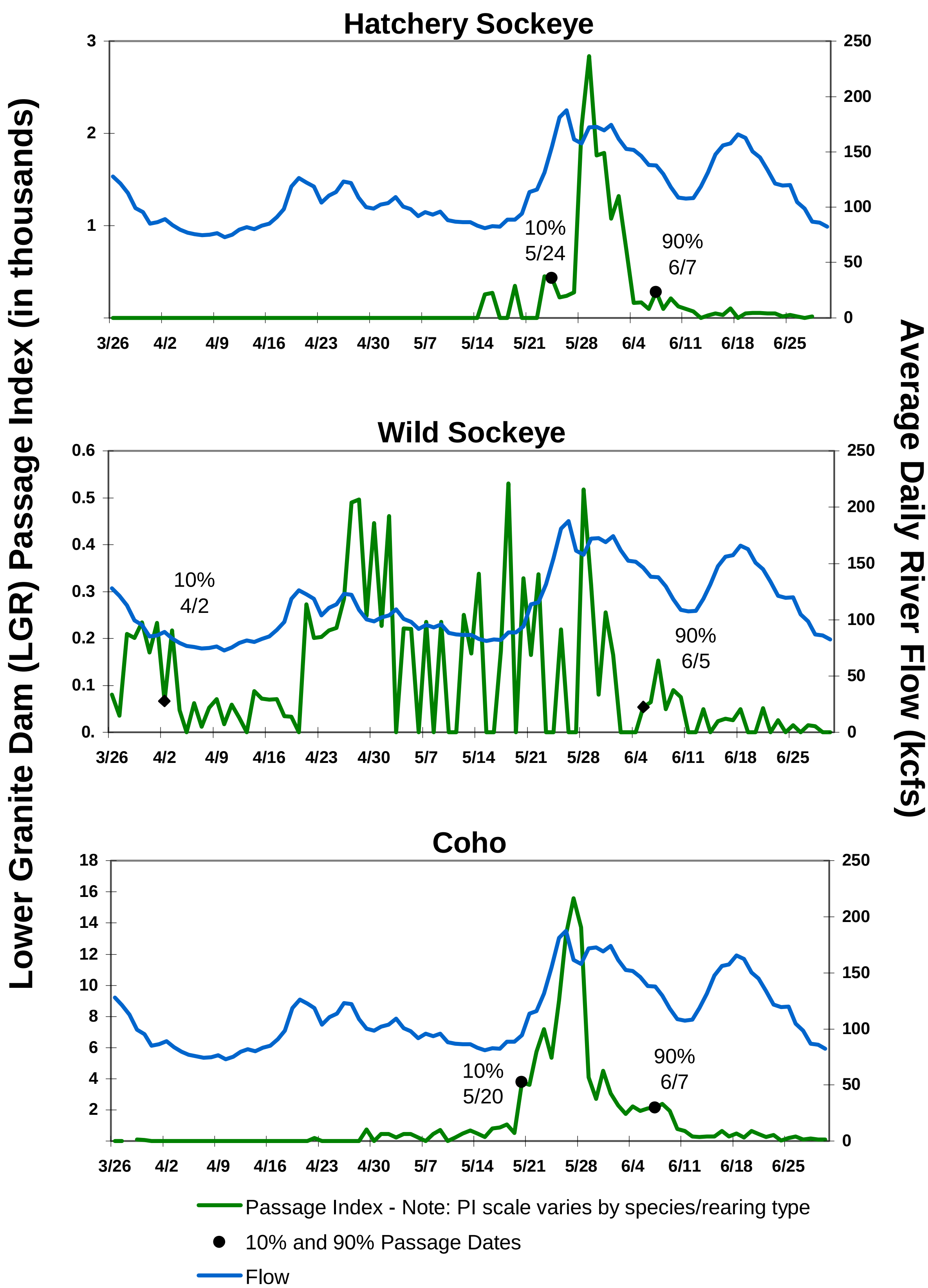

FIGURE D-8. Smolt migration timing at Lower Granite Dam and associated flows, 1999.

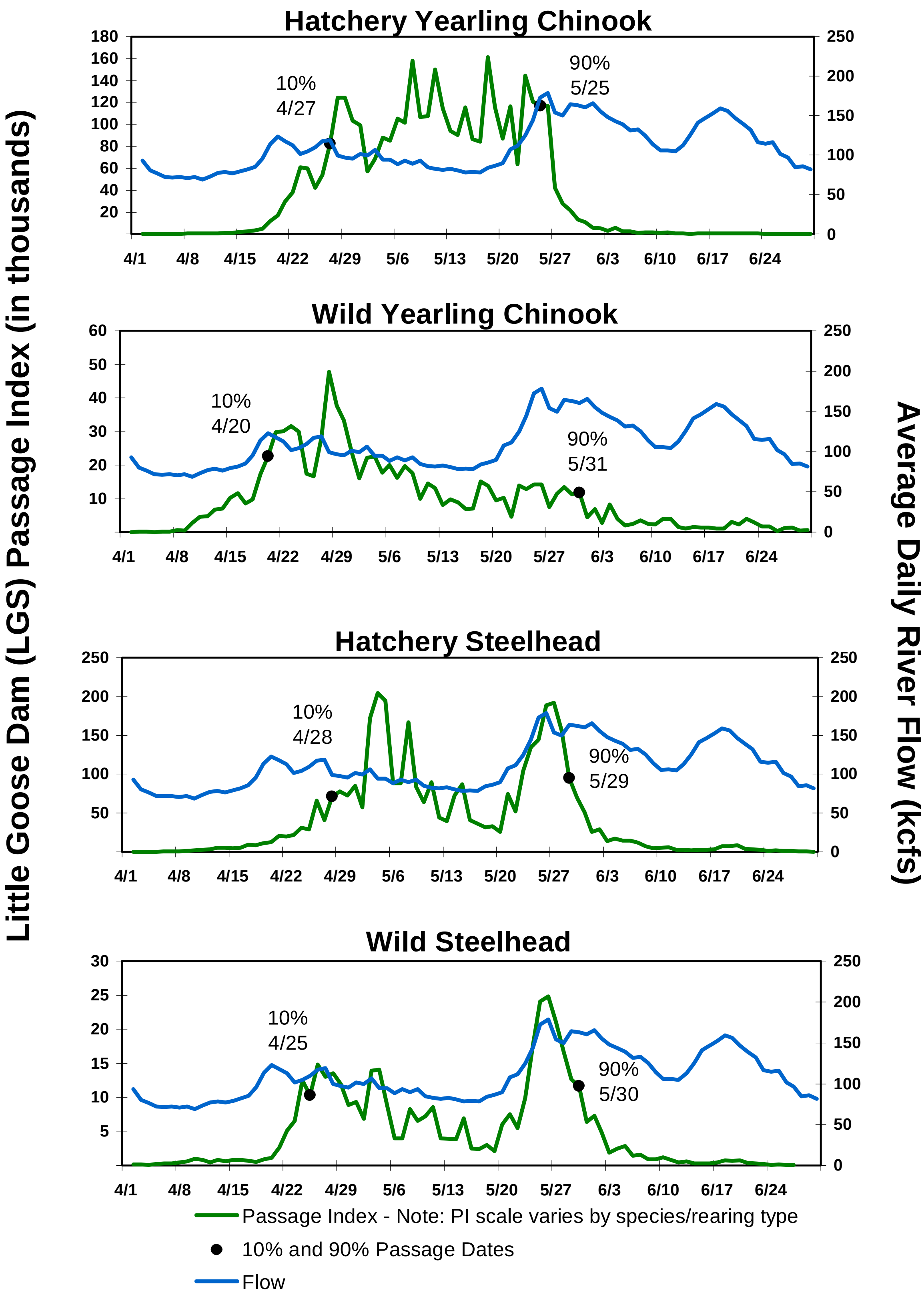

FIGURE D-9. Smolt migration timing at Little Goose Dam with associated flows, 1999.

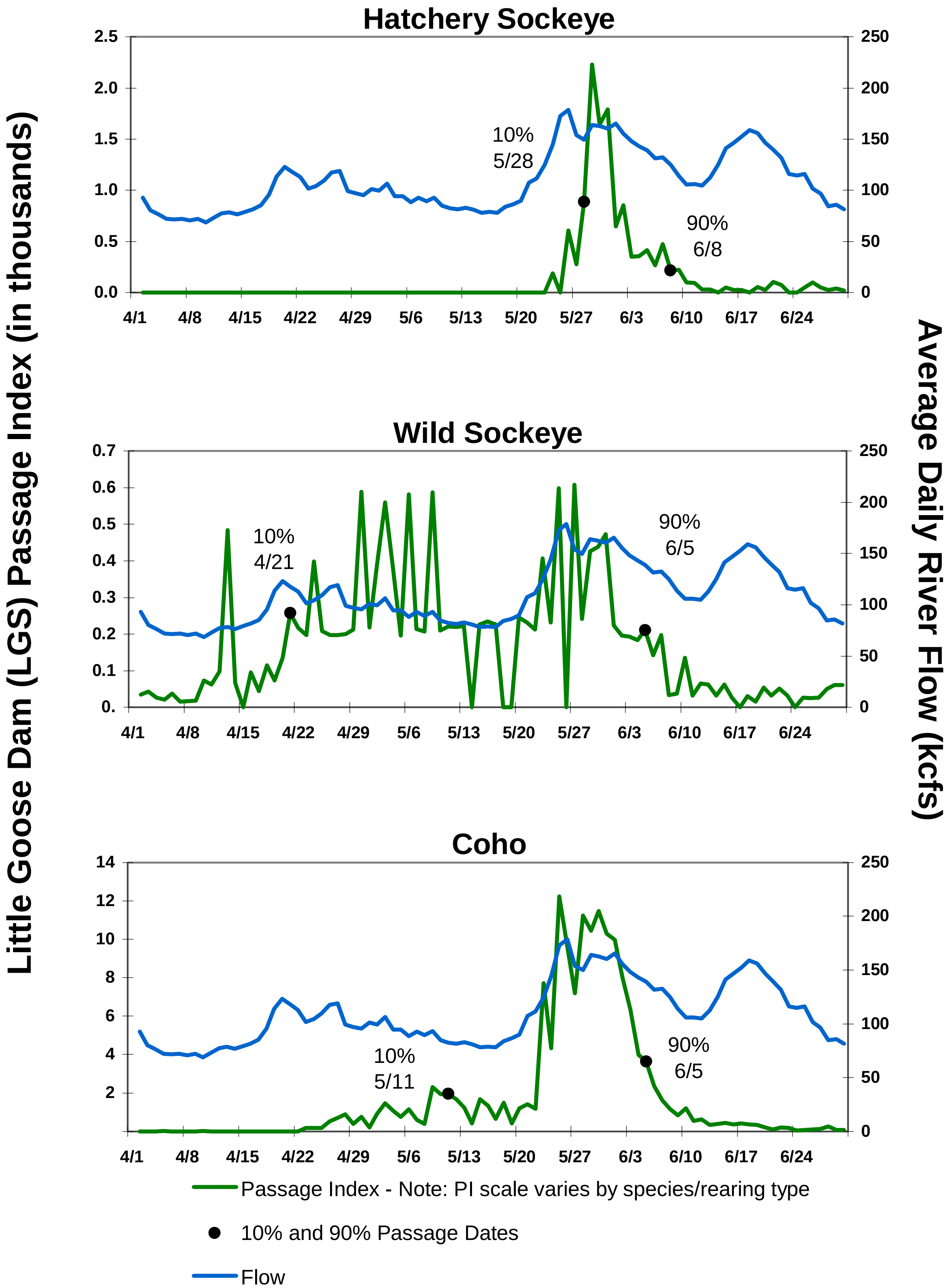

FIGURE D-10. Smolt migration timing at Little Goose Dam with associated flows, 1999.

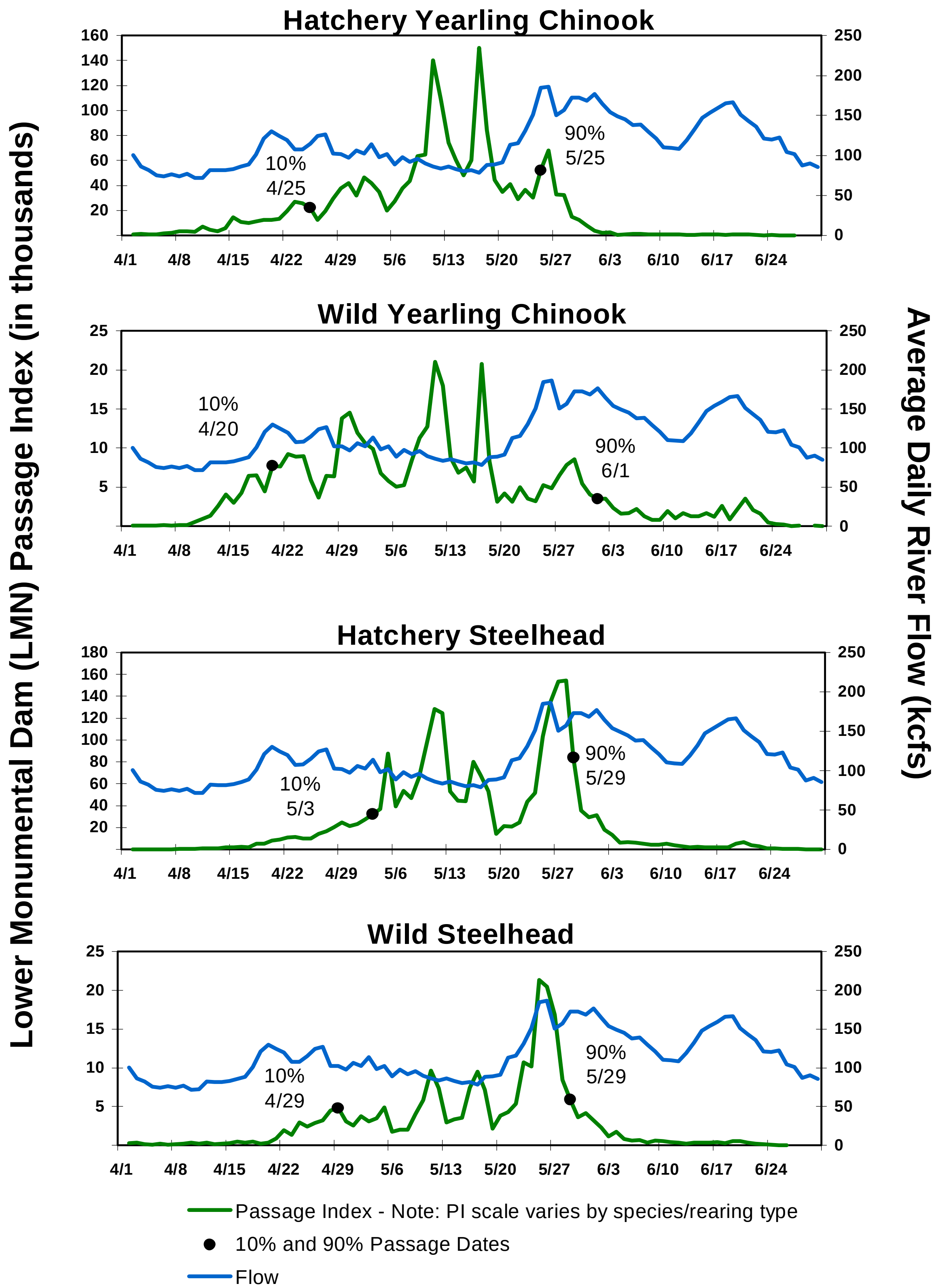

FIGURE D-11. Smolt Migration timing at Lower Monumental Dam with associated flow, 1999.

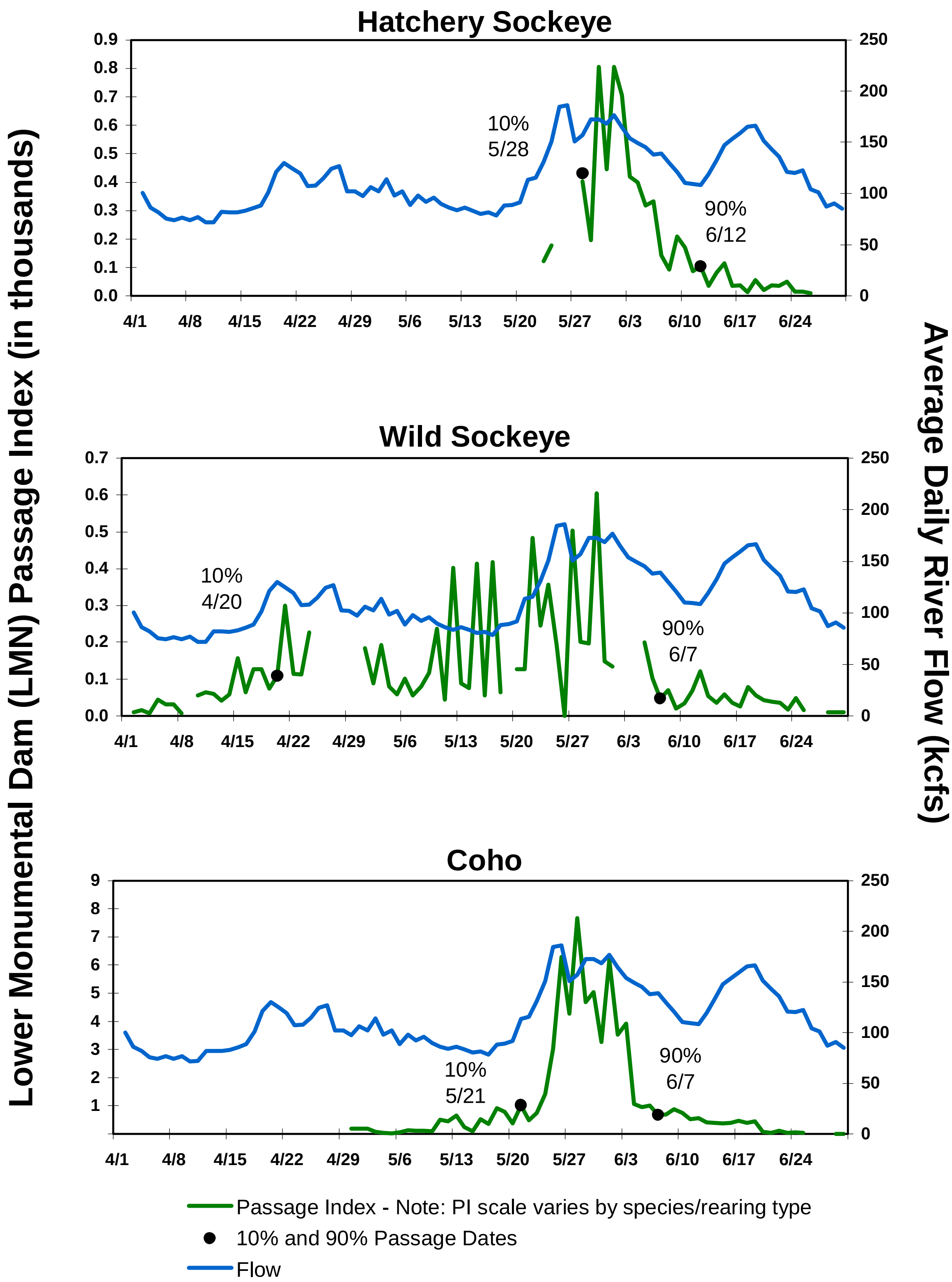

FIGURE D-12. Smolt migration timing at Lower Monumental Dam with associated flow, 1999.

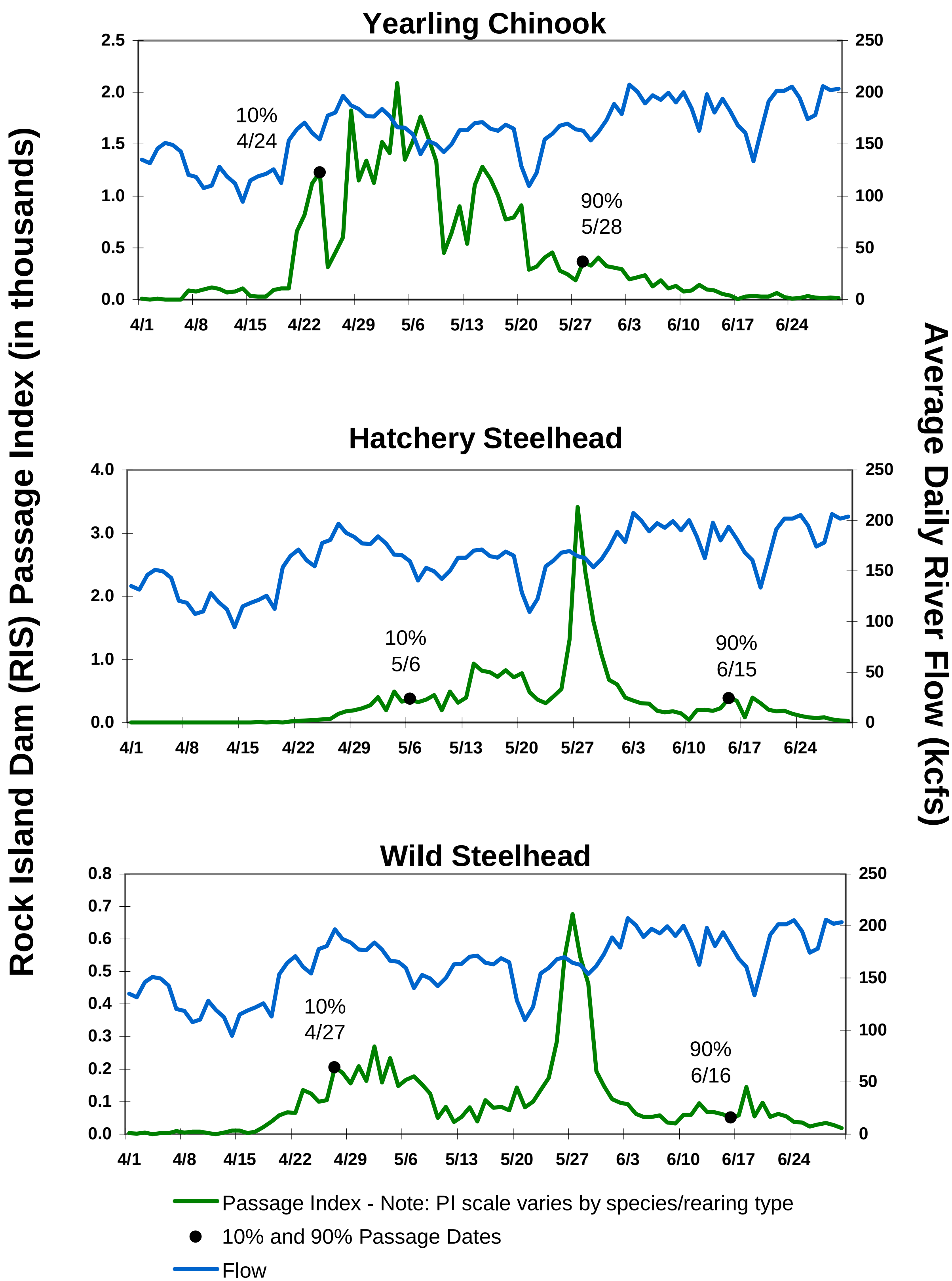

FIGURE D-13. Smolt migration timing at Rock Island Dam with associated flow, 1999.

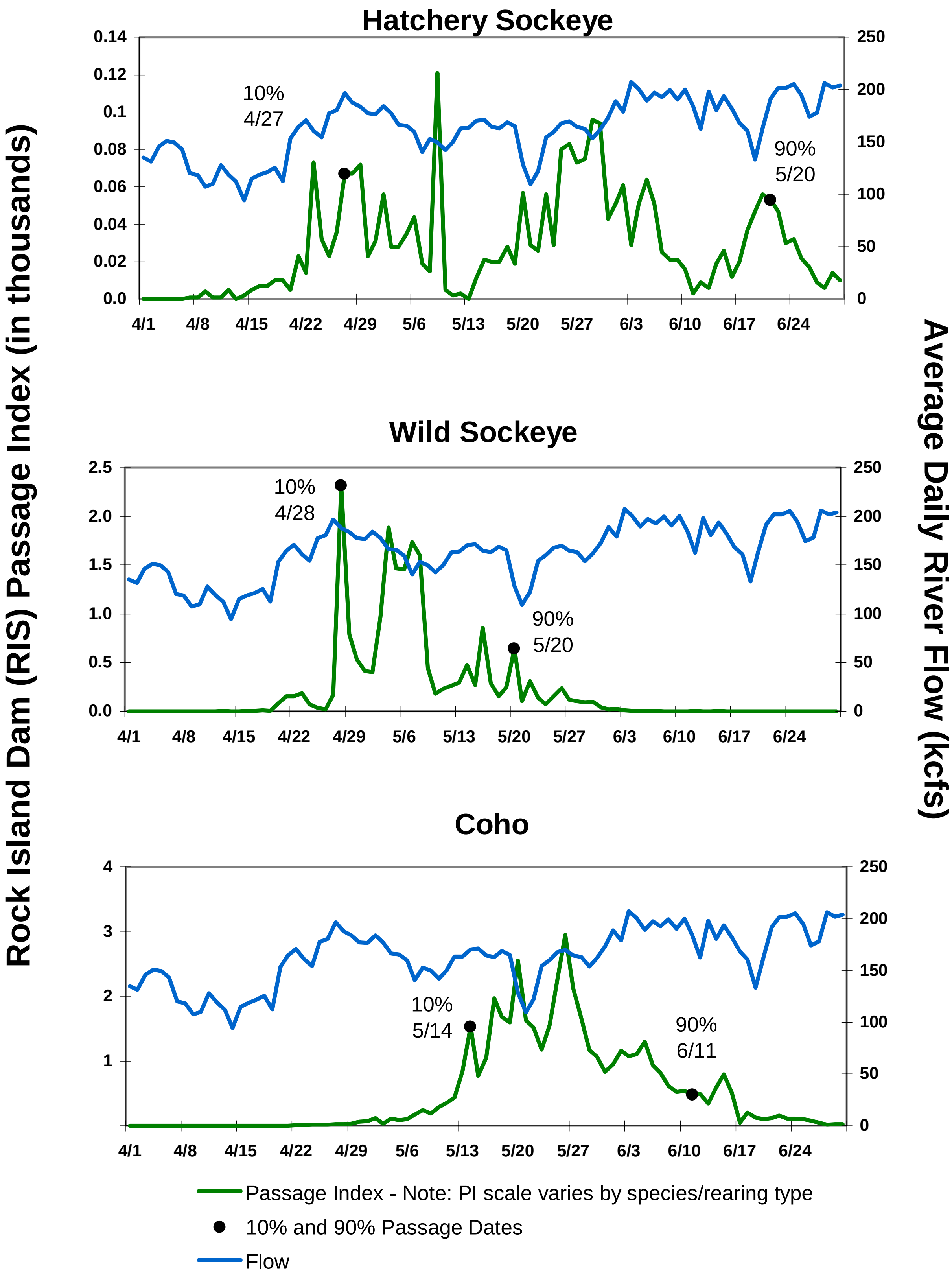

FIGURE D-14. Smolt migration timing at Rock Island Dam with associated flow, 1999.

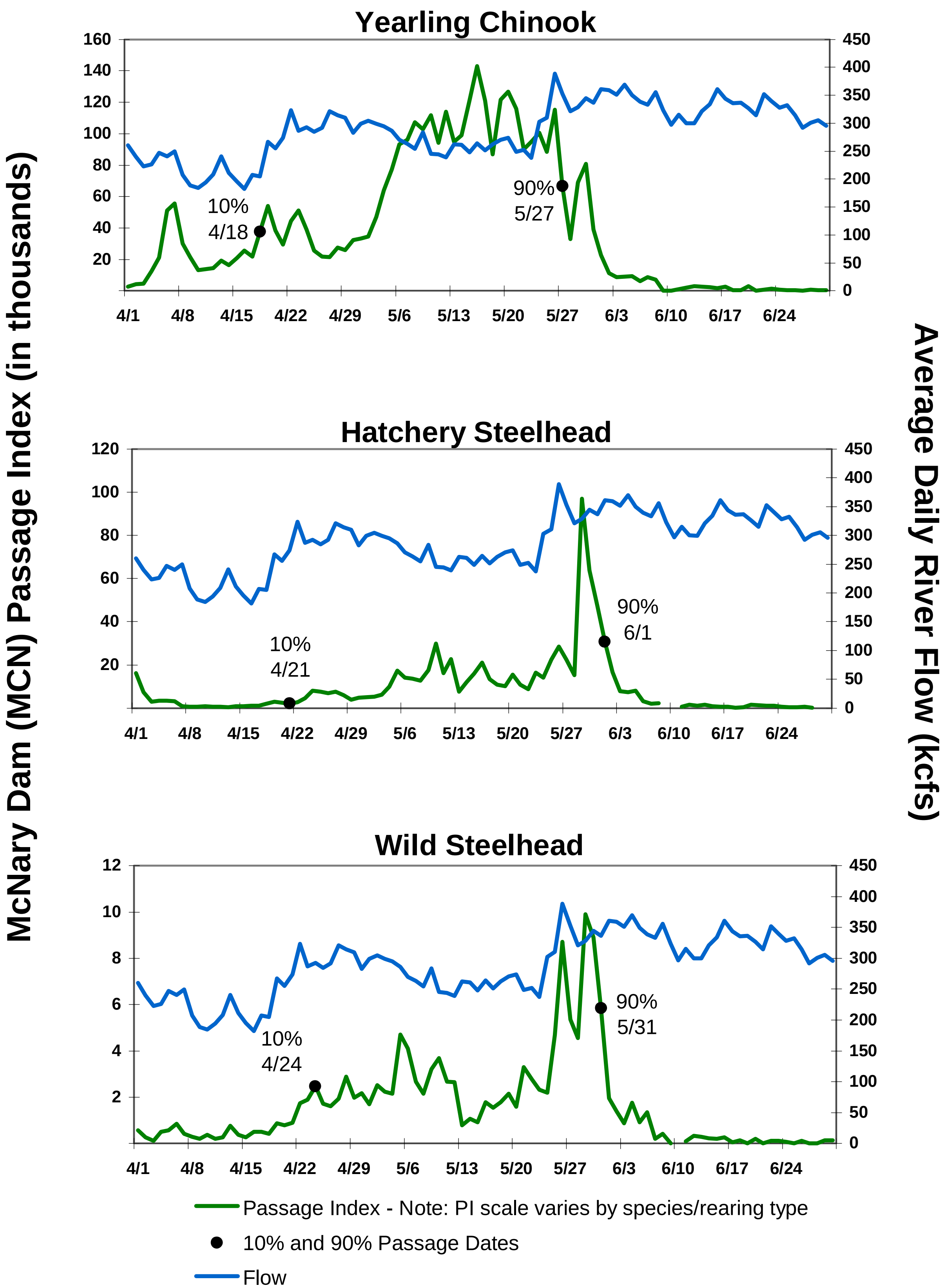

FIGURE D-15. Smolt migration timing at McNary Dam with associated flow, 1999.

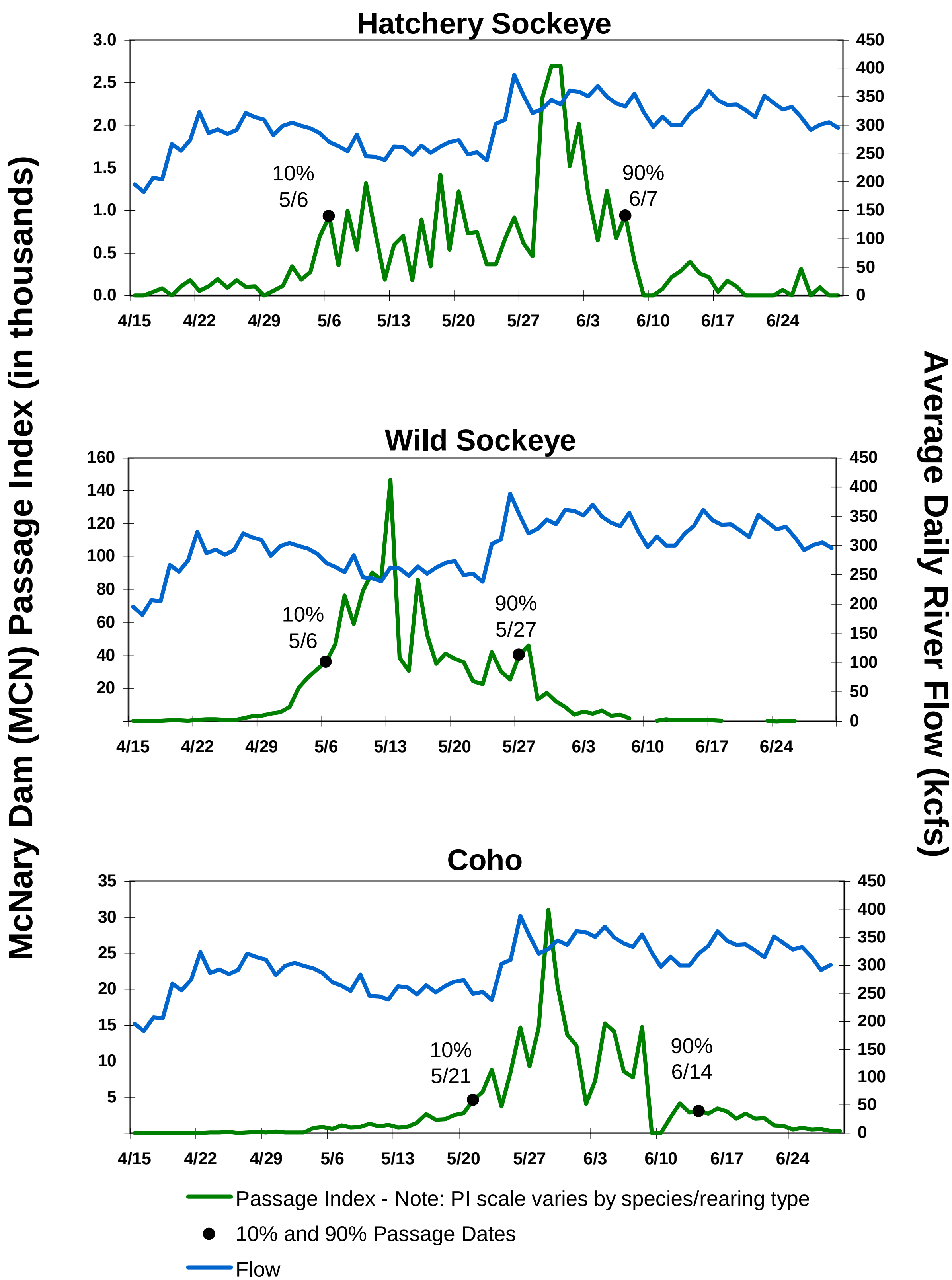

FIGURE D-16. Smolt migration timing at McNary Dam with associated flow, 1999.

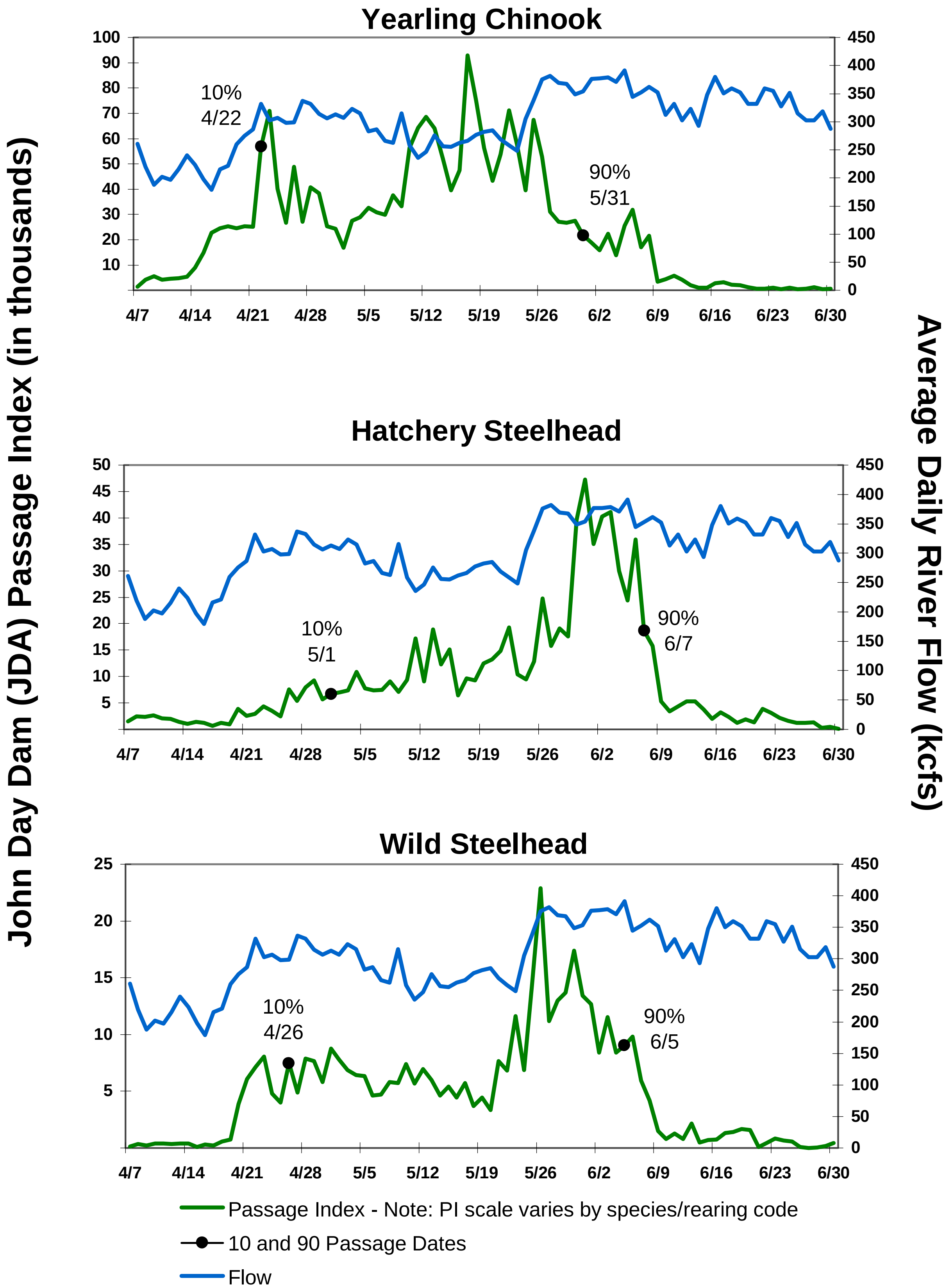

FIGURE D-17. Smolt migration timing at John Day Dam with associated flow, 1999.

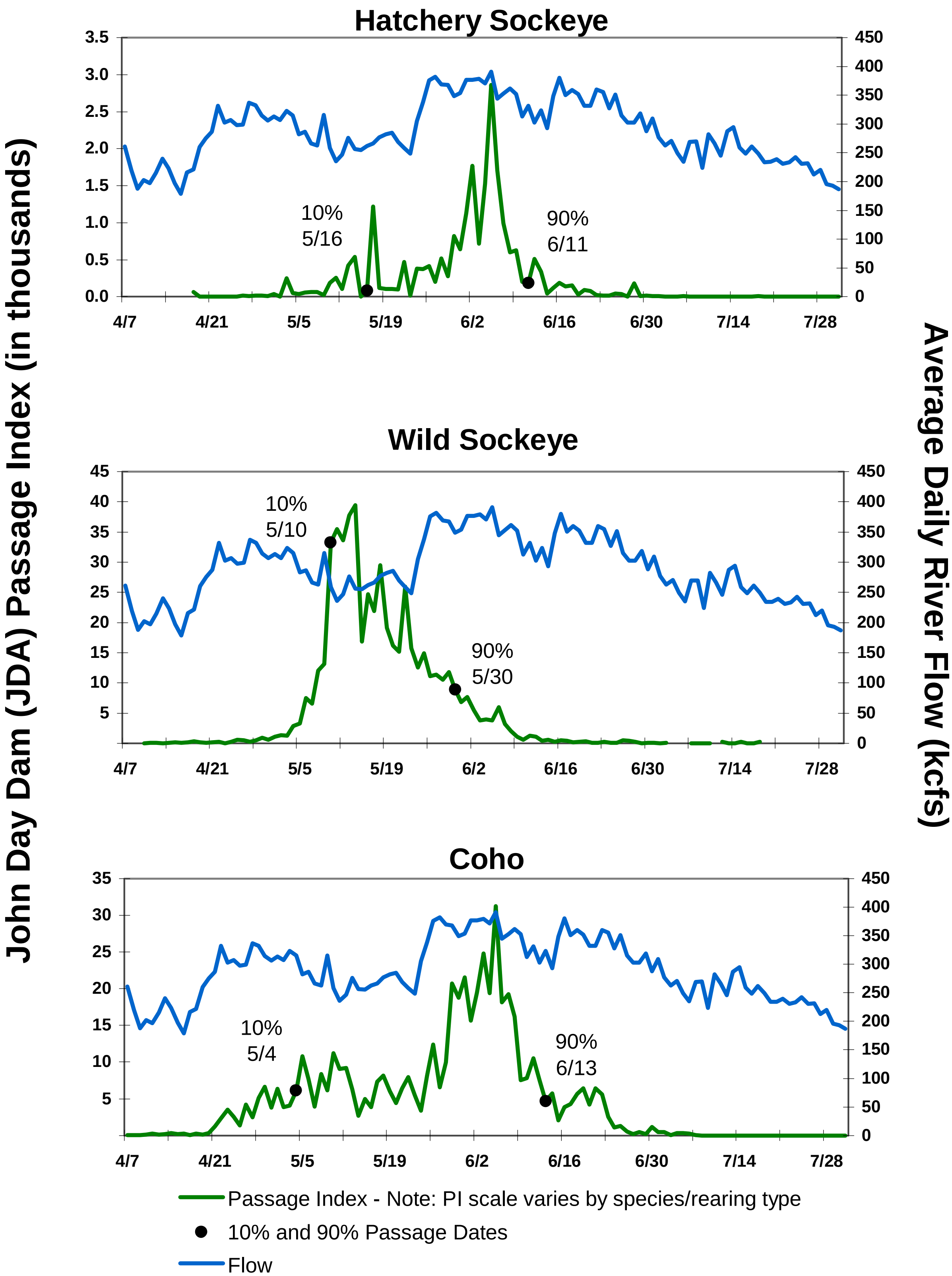

FIGURE D-18. Smolt migration timing at John Day Dam with associated flow, 1999.

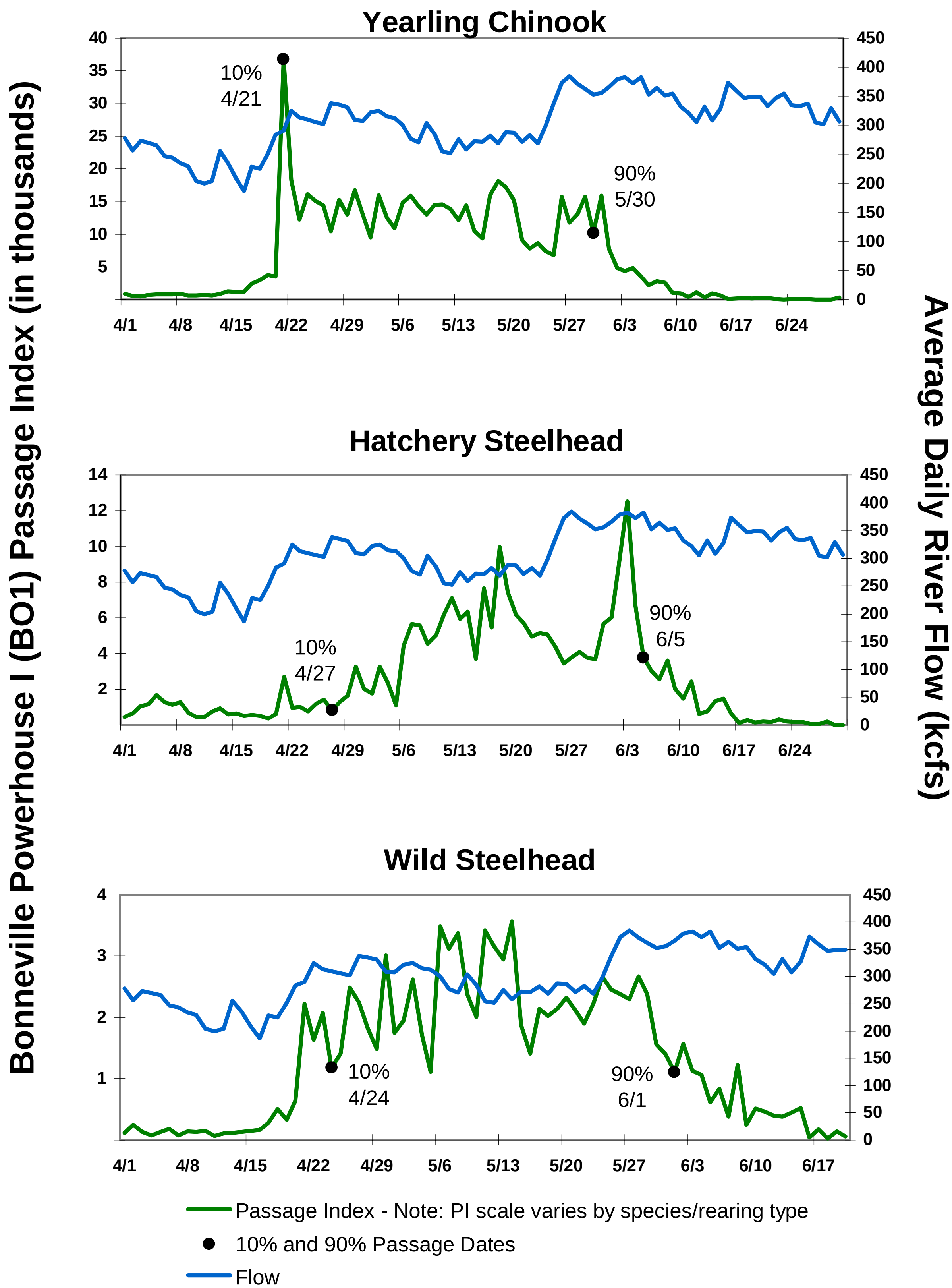

FIGURE D-19. Smolt migration timing at Bonneville Powerhouse I with associated flow, 1999.

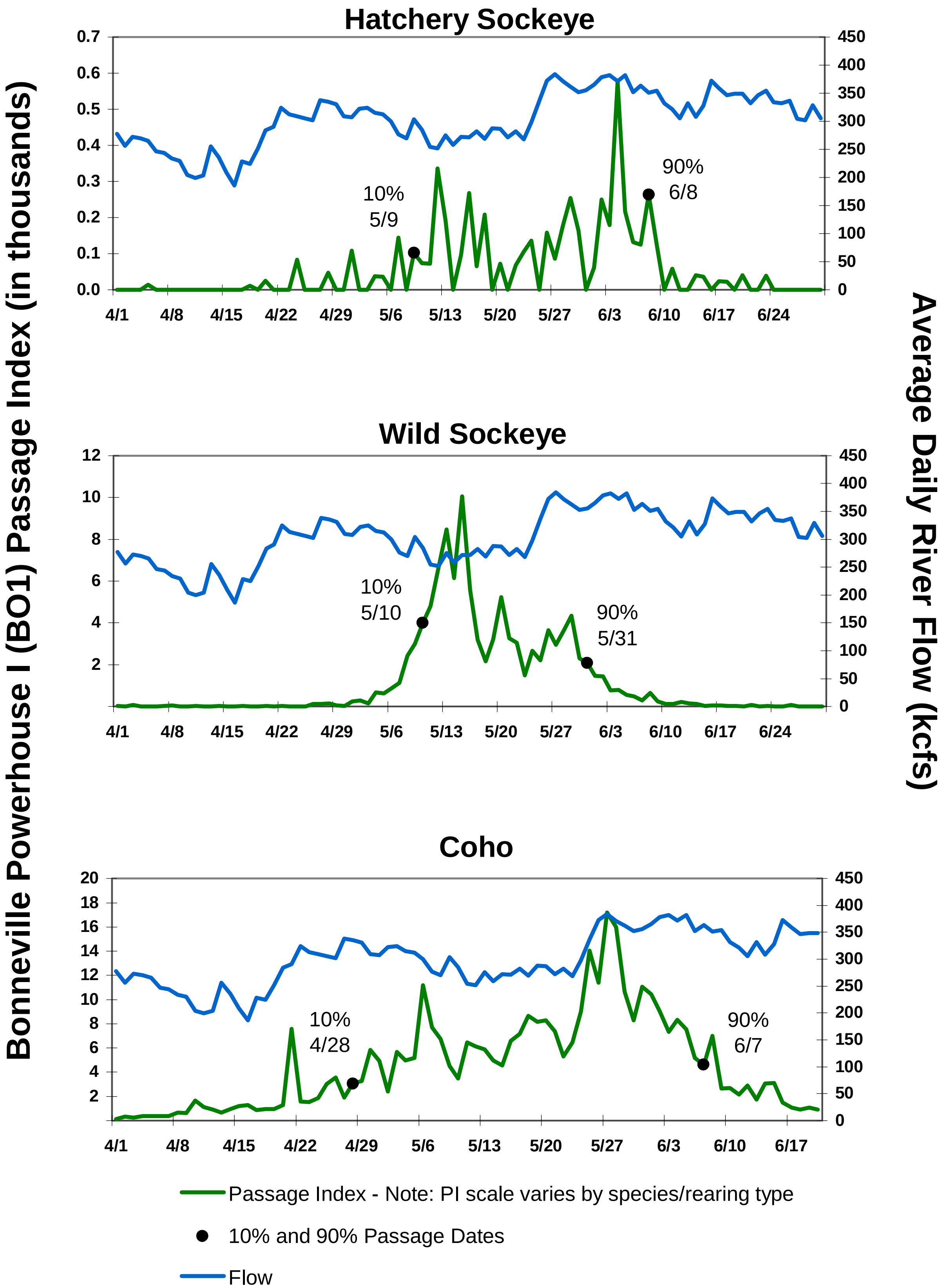

FIGURE D-20. Smolt migration timing at Bonneville Powerhouse I with associated flow, 1999.

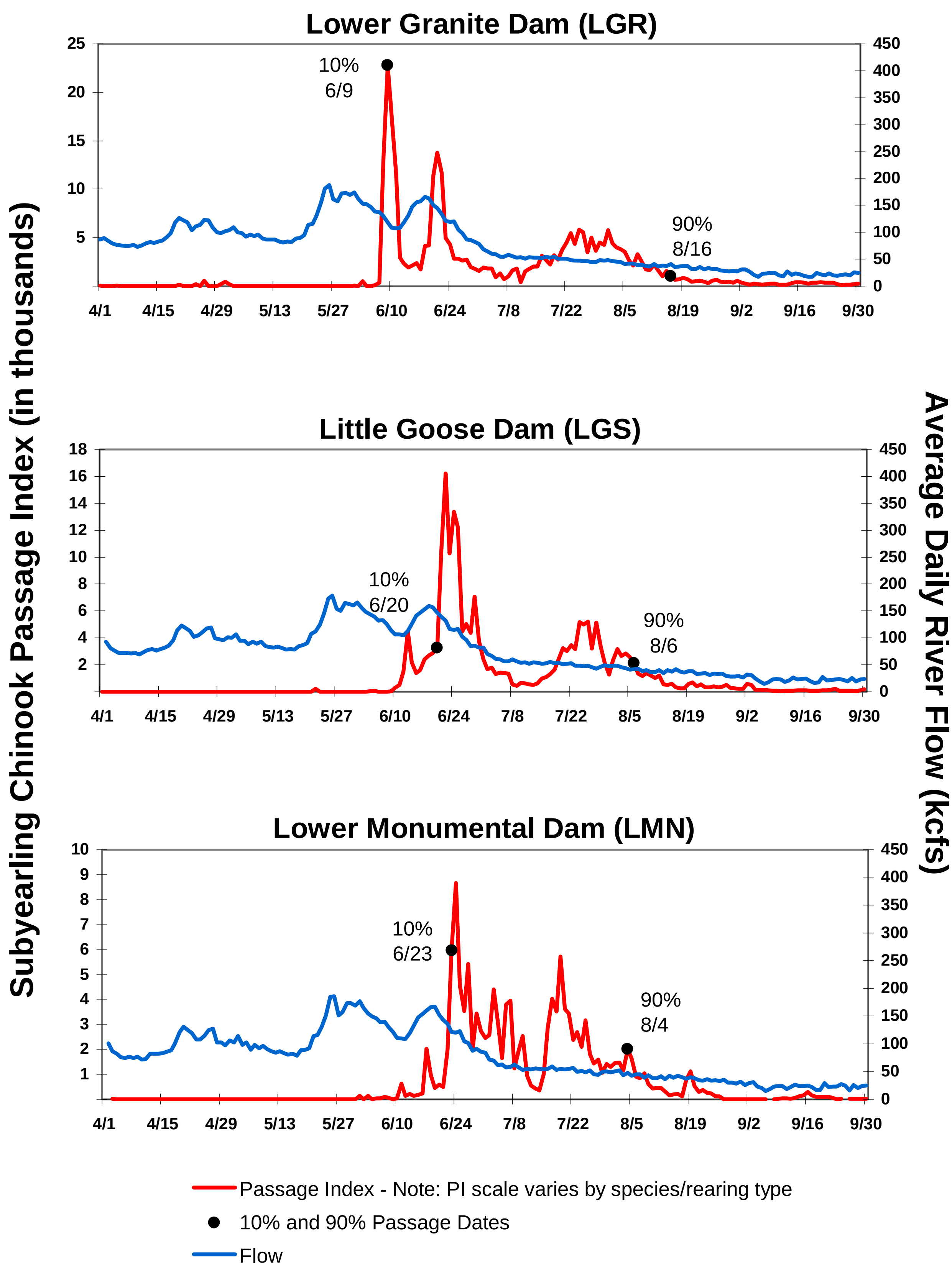

FIGURE D-21. Hatchery subyearling chinook smolt migration timing at Snake River sites with associated flow, 1999.

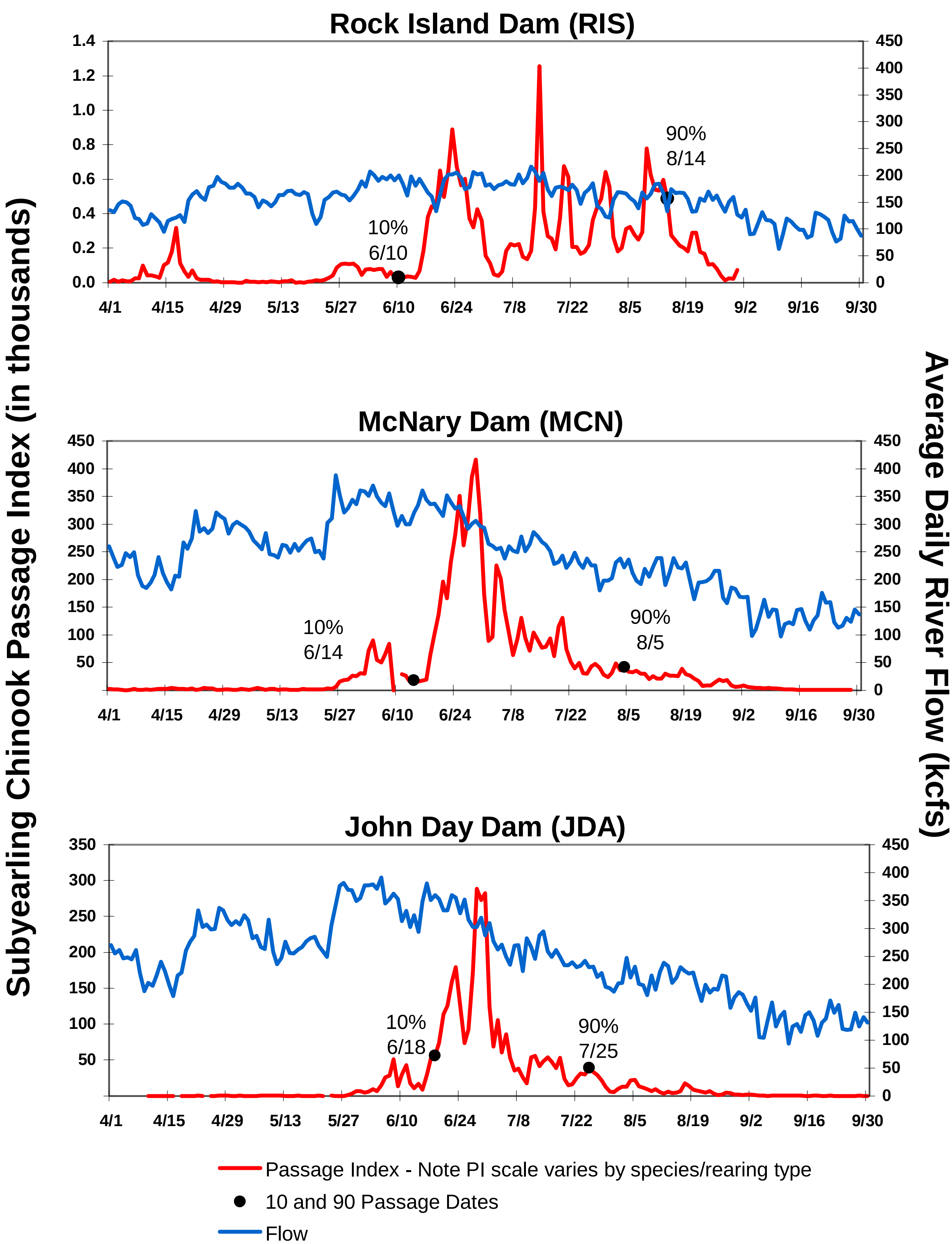

FIGURE D-22. Wild subyearling chinook smolt migration timing at Snake River sites with associated flow, 1999.

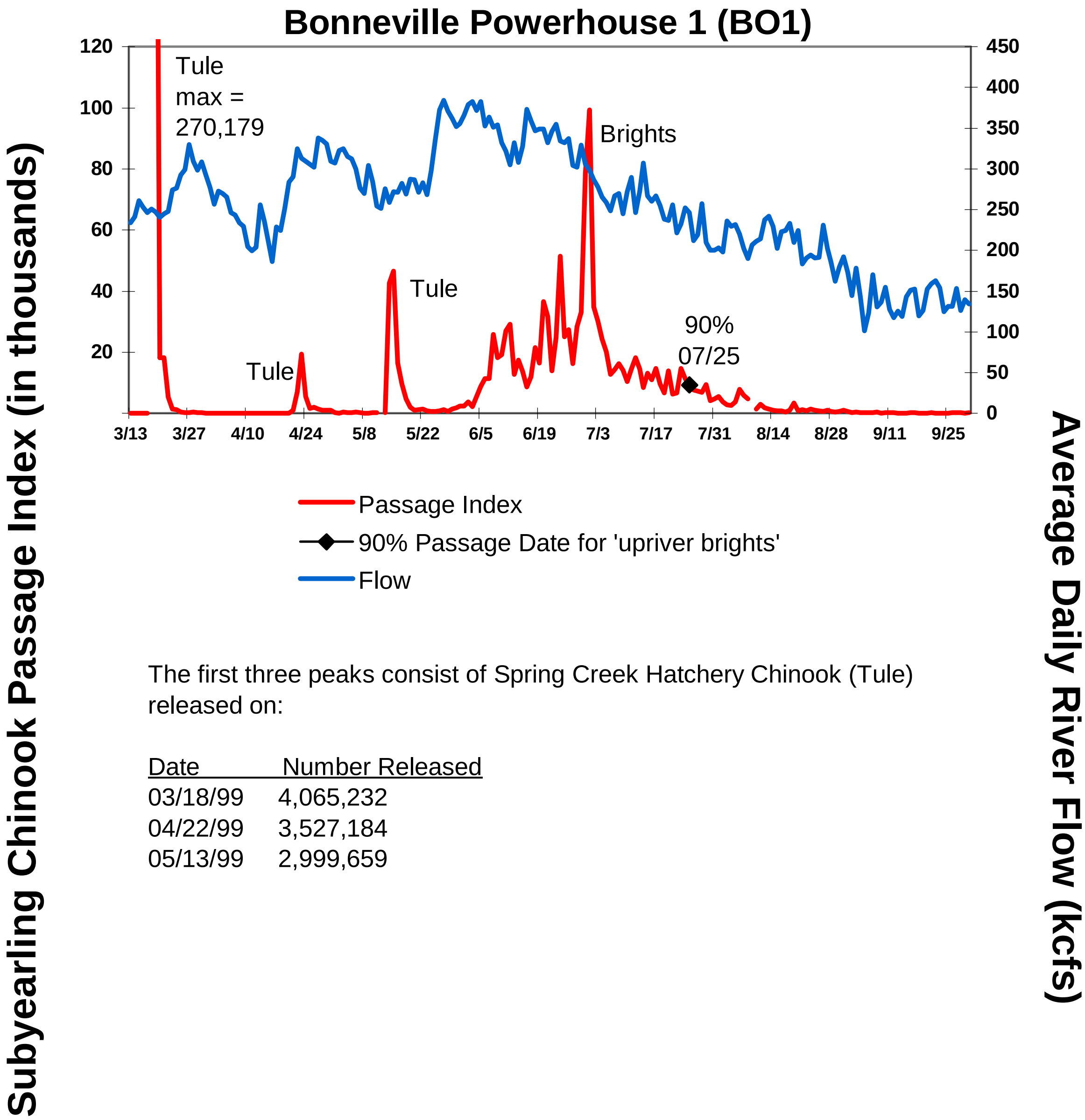

FIGURE D-23. Subyearling chinook smolt migration timing at Columbia River sites with associated flow, 1999.

APPENDIX E

Monitoring Site Comments Pertaining to Collections in 1999

Table __. Comments on operational activities/problems that have an influence on monitoring data collected during 1999.

Site	Batch	** Sample Date ** Start	End	Comment
IMN	99001	3/1/99	3/2/99	Trap B not Operating
IMN	99002	3/2/99	3/3/99	Trap B not Operating
IMN	99016	3/20/99	3/21/99	Woody debris caused the trap to stop. The sample was lost while removing the debris. The cleaning wheel was inspected for injured fish and mortalities.
IMN	99021	3/25/99	3/26/99	High flows and debris sank traps A and B between 5 and 8 am.
IMN	99022	3/27/99	3/28/99	Trap B not Operating
IMN	99023	3/28/99	3/29/99	Trap B not operating
IMN	99024	3/29/99	3/30/99	Trapping interrupted from 1500 to 1600 due to maintenance. No fish were captured in trap b. The cleaning drum was not operating properly.
IMN	99025	3/30/99	3/31/99	Repairs to the cleaning drum caused an interruption from 0100 to 0330. The trap that 42 of the hatchery chinook came from was not noted. These fish were reported in trap A.
IMN	99027	4/1/99	4/2/99	Trap interrupted from 1300 to 1700 for travel to Office.
IMN	99028	4/2/99	4/3/99	Trap B was raised 4 inches to prevent damage to the cone on the bottom.
IMN	99043	4/17/99	4/18/99	A portion of the catch, 576 hatchery chinook, 123 wild chinook, 66 hatchery steelhead and 24 wild steelhead, were estimated from 6 of 18 buckets.
IMN	99044	4/18/99	4/19/99	Trapping was interrupted from 20:00 to 21:00 due to repositioning of the trap.
IMN	99049	4/23/99	4/24/99	The cleaning wheel stopped operating around 0300 and some fish were lost out of the back of the trap.
IMN	99050	4/24/99	4/25/99	Trapping was interrupted due to debris from 0100 to 0130 and the trap failed at 0430.
IMN	99051	4/25/99	4/26/99	High flows and debris. No sample attempted.
IMN	99052	4/26/99	4/27/99	Debris in main drum and the malfunction of the cleaning wheel may have let some fish escape and caused mortality.
IMN	99053	4/27/99	4/28/99	The trapping ended early due to a worker being injured at the site.
IMN	99060	5/6/99	5/7/99	Trapping was interrupted between 04:15 and 04:45 to remove a calf.
IMN	99062	5/10/99	5/11/99	One bucket with approximately 30 unsampled fish from trap A was accidentally released. Trap B began fishing at 16:00.
IMN	99067	5/17/99	5/18/99	Trap B stopped turning between 4 and 5 AM due to debris.
IMN	99068	5/18/99	5/19/99	A portion of the catch was estimated. High water allowed fish to escape out of the back of the trap.
IMN	99069	5/19/99	5/20/99	High water allowed fish to escape out of the back of the trap.
IMN	99070	5/20/99	5/21/99	High flows and debris forced sampling to end early.
IMN	99071	5/23/99	5/24/99	Not operating due to high flows and heavy debris.
IMN	99072	5/24/99	5/25/99	Not operating due to high flows and heavy debris.
IMN	99074	5/26/99	5/27/99	Not operating trap due to high water.
IMN	99075	5/27/99	5/28/99	Not operating due to high flows and debris.
IMN	99076	5/30/99	5/31/99	Not operating due to high flows and debris.
IMN	99077	5/31/99	6/1/99	Not operating due to high flows and debris.
IMN	99078	6/1/99	6/2/99	Trapping was interrupted from 03:30 to 03:45.
IMN	99081	6/6/99	6/7/99	Trapping was interrupted from 23:15 to 23:30. There were no records kept of which trap the fish were captured from. The catch from Trap B was added to Trap A.
IMN	99082	6/7/99	6/8/99	The debris drum on Trap A was not working.
IMN	99083	6/8/99	6/9/99	Trapping was interrupted for an hour starting at 10:45 AM to repair debris drum. No fish were lost during the repair.
IMN	99084	6/9/99	6/10/99	The traps were raised for repairs from 17:00 to 20:00.
IMN	99085	6/10/99	6/11/99	There was no record in the tagging file of which trap the fish were captured in. All fish in the tagging file will be assumed to be from trap A. Trapping was interrupted for 30 minutes to clean out debris. No fish escaped.
IMN	99086	6/13/99	6/14/99	Trap B stopped sometime between 0300 and 0700 due to debris.
IMN	99087	6/14/99	6/15/99	Fifteen fish escaped from trap B while netting.
IMN	99088	6/15/99	6/16/99	Trapping was interrupted from 0130 to 0230 due to large debris. Trap B was not running.
IMN	99089	6/16/99	6/17/99	Trap B was not operating.
IMN	99090	6/17/99	6/18/99	Trap B not Operating.
IMN	99091	6/20/99	6/21/99	Trap B not operating.
IMN	99092	6/21/99	6/22/99	Trap B not operating.
IMN	99093	6/22/99	6/23/99	Trap b not operating
IMN	99094	6/23/99	6/24/99	Trap B not operating. This was the final day of spring trapping.

Table (continued)

		** Sample Date **		
Site	Batch	Start	End	Comment
WTB	99022	4/11/99	4/12/99	14.5 ACTUAL SAMPLE HOURS
WTB	99033	4/26/99	4/27/99	Trap fished 04/26/99 1030-1700 hrs at 10.0 meters. Fished 1700 hrs 04/26/99 to 04/27/99 1300hrs at 30.0 meters. Moved due to high flows.
WTB	99036	4/29/99	4/30/99	Trap was moved to 10M at 15:30 PST. There are several SH with "no marks."
WTB	99050	5/19/99	5/20/99	We moved the trap last night from 10M to 30M at 20:00 P.S.T.
GRN	99053	5/25/99	5/26/99	Stopped fishing due to excessive debris
GRN	99054	5/26/99	5/27/99	Only fished night due to high debris loads during daytime
GRN	99059	6/2/99	6/3/99	Support cable broke, trap was half under water and fish could escape.
GRN	99060	6/3/99	6/4/99	Did not operate trap due to broken anchor cable
LEW	99001	3/14/99	3/15/99	Shear pin broke when we arrived. No idea how long trap was not working. Replaced shearpin. Trap ran >= 1.0 hours.
LEW	99002	3/15/99	3/16/99	Shear pin broken when arrived at trap. Replaced pin and restarted trap at 1000. Trap ran >= 6.0 hours.
LEW	99004	3/17/99	3/18/99	Sheer pin broken. Restarted at 1200. Trap ran >=7.0 hours.
LEW	99007	3/22/99	3/23/99	sheer pin broken; replaced; restarted 11:00. Trap ran >= 7.0 hours.
LEW	99008	3/23/99	3/24/99	A lot of debris blocking trap intake. Therefore, hindering catch.
LEW	99009	3/24/99	3/25/99	Sheer pin broken when arrived; no idea how long trap down; replaced; restarted at 10:00. Trap ran >=6.0 hours.
LEW	99014	3/31/99	4/1/99	Sheer pin broken on arrival (4/1/99 09:45); Unknown how long trap was not running. Trap did run at least 6 hours on 3/31/99.
LEW	99029	4/21/99	4/22/99	Trap was not running when arrived at 0700. Shear pin broken. Trap ran >=14.0 hours.
LEW	99038	5/4/99	5/5/99	Shear pin broken upon arrival. Known working hours are from 11:30 to 16:30 on 05/04/99, and from 09:00 to 11:30 on 05/05/99.
LEW	99050	5/20/99	5/21/99	Trap was down from 9-10 am for maintenance.
LEW	99054	5/24/99	5/25/99	Trap was pulled 05/24/99 2100 hrs. Fish in sample caught 05/24/99 1200 hrs to 05/24/99 2100 hrs.
LGR	99108	7/10/99	7/11/99	Sample slidegate air hose failure between 1400 and 0700, both gates apparently failed to open properly.
LMN	99007	4/7/99	4/8/99	32 hour sample due to change in sample start time, this was due to the transport method being changed to barge from truck
LMN	99055	5/25/99	5/26/99	All fish for last two days were bypassed at 1500 hrs to river. There was no room on the barge.
LMN	99056	5/26/99	5/27/99	Due to barge problems, Raceway #1 (sample fish) are being held over, Raceway #2 was bypassed, and
LMN	99065	6/4/99	6/5/99	Due to a malfunction in the "B" side sample gate, that gate did not open from 1400 hrs - 1745hrs.
LMN	99126	8/4/99	8/5/99	Incomplete sample. Power was of f on Aug 4 from 1240-1330 and 1415-1705. No sample taken during outages.
LMN	99130	8/8/99	8/9/99	These sample fish could have been held in the sample holding tank up to 48 hours!
LMN	99140	8/18/99	8/19/99	sampled at 100% from 0700 to 1100, changed sample rate to 25% but did not crowd
LMN	99148	8/26/99	8/27/99	No sample taken
LMN	99149	8/27/99	8/28/99	No sample taken
LMN	99150	8/28/99	8/29/99	No sample Taken
LMN	99151	8/29/99	8/30/99	No sample taken
LMN	99152	8/30/99	8/31/99	No sample taken
LMN	99153	8/31/99	9/1/99	No sample taken
LMN	99154	9/1/99	9/2/99	NO SAMPLE TAKEN
LMN	99155	9/2/99	9/3/99	No sample taken
LMN	99156	9/3/99	9/4/99	NO SAMPLE
LMN	99157	9/4/99	9/5/99	NO SAMPLE TAKEN
LMN	99158	9/5/99	9/6/99	NO SAMPLE TAKEN
LMN	99159	9/6/99	9/7/99	NO SAMPLE
LMN	99160	9/7/99	9/8/99	No sample taken
LMN	99161	9/8/99	9/9/99	Incomplete sample due to 0800 starting time
LMN	99175	9/22/99	9/23/99	No sample taken

Table (continued)

		** Sample Date **		
Site	Batch	Start	End	Comment
MCN	99001	3/29/99	3/30/99	Juvenile fish facility began operation. Operated in emergency bypass until 0900 on3/29, primary bypass from 1100 to1245, secondary bypass (sampling & PIT tag detection) at 1245 on 3/29. Steelhead "B" diversion is not operational, awaiting repairs.
MCN	99009	4/6/99	4/7/99	PIT tag diversion line clogged at 2200, fish routed to raceway
MCN	99019	4/16/99	4/17/99	Facility was in Primary Bypass from 1030 hrs until 1130 hrs to pressure wash the flume driers.
MCN	99030	4/27/99	4/28/99	Facility in primary bypass 09:45-11:15 for cleaning and repairs.
MCN	99031	4/28/99	4/29/99	Facility switched to primary bypass from 1715 to 2300 on April 28 due to high debris load.
MCN	99037	5/4/99	5/5/99	Debris blockage in River 1 bypass line; all fish diverted to raceway from 0505 to 0700.
MCN	99038	5/5/99	5/6/99	Fish were routed to raceway until 8:45 on April 5 due to a debris blockage.
MCN	99047	5/14/99	5/15/99	All fish are being routed out the secondary bypass line with the PIT tag diversion gates off.
MCN	99072	6/8/99	6/9/99	Facility switched to primary bypass at 0700. Facility will be operated in emergency bypass for mid-season facility cleanout and inspection.
MCN	99073	6/9/99	6/10/99	Facility in primary bypass for mid-season cleanout and maintenance.
MCN	99074	6/10/99	6/11/99	Facility switched back to secondary bypass at 1130 on 6/10 after mid-season inspection.
MCN	99078	6/14/99	6/15/99	Sample gates were turned off for approximately 15 minutes for maintenance.
MCN	99092	6/28/99	6/29/99	B side PIT tag diversion gate off from 1205 to 1503
MCN	99100	7/6/99	7/7/99	Facility was unwatered from 1344 to 1750 for repairs to the side dewatering brush.
MCN	99107	7/13/99	7/14/99	Facility switched to primary bypass at 0715 to repair side water elimination screen. Channel unwatered, fish held in gatewells, return to collection at 1400.
MCN	99109	7/15/99	7/16/99	Facility in primary bypass due to a blockage in a pipe from 02:55am on 7/16 until 03:15am. Chinook "A" sample gate turned off from 03:20 to 03:35 due to overflow of flume.
MCN	99110	7/16/99	7/17/99	A side PIT tag diversion gate off from 1500 to 1615 due to blown airline.
MCN	99116	7/22/99	7/23/99	McNary has now gone to daily trucking.
MCN	99133	8/8/99	8/9/99	Primary bypass from 1505 hrs - 1518 hrs.
MCN	99137	8/12/99	8/13/99	Biased sample due to repair work on the "B" side sample gate from 1305 to 1640
MCN	99154	8/29/99	8/30/99	Due to a power outage, the sample tanks were turned off at 0600 hrs.
MCN	99158	9/2/99	9/3/99	McNary has a biased sample due to a power outage. The "A" side sample gate was open for 30 minutes, while the "B" side gate was closed. The whole facility was in Primary Bypass from 1530 hrs. - 1630 hrs.
MCN	99163	9/7/99	9/8/99	Power outage from 12:50 - 13:15 and 13:55 - 14:05. No sample during outage.
MCN	99165	9/9/99	9/10/99	Power outage from 11:05 to 11:15. No sample during outage.
MCN	99183	9/27/99	9/28/99	Facility switched to primary bypass at 7:50pm due to mechanical problems with the incline dewatering cleaner.
MCN	99184	9/28/99	9/29/99	Facility in primary bypass 0700-1100, and emergency bypass 1100-0700 due to mechanical problems with incline dewatering screen cleaning brush.
JDA	99001	4/1/99	4/1/99	First partial day of sampling (2000-2400) at John Day. Rotating gate set to 25% sample rate and then changed to 10%
JDA	99002	4/2/99	4/2/99	Biased sample day. Sample stopped at 1200 and put into bypass mode. Smolt Monitoring facility dewatered approx 1500. (Primary dewatering screen cleaner failure and rotating gate malfunctioned).
JDA	99003	4/3/99	4/3/99	No sample taken today. Whole system still dewatered.
JDA	99004	4/4/99	4/4/99	No sample taken today. Whole system still dewatered.
JDA	99005	4/5/99	4/5/99	No samples today. Smolt Monitoring Facility is still dewatered.
JDA	99006	4/6/99	4/6/99	No samples today. Smolt Monitoring Facility dewatered
JDA	99007	4/7/99	4/7/99	Watered up and ready for sampling again. Started sampling at 2000-2400
JDA	99014	4/14/99	4/14/99	Biased sample day due to 3 way rotational gate repairs. Switch gate put into bypass mode 0800-1400.
JDA	99070	6/9/99	6/9/99	The elevated chute, PDS, transport flume, and FDS were de-watered for inspection purposes this morning at approx. 10:30. Electrical problems involving the crest gate prevented a "re-water up" and fish were bypassed to the river from the tainter gate.
JDA	99071	6/10/99	6/10/99	Biased sample day due to malfunction of the crest gate. Normal sampling commenced at approximately 10:30.
JDA	99106	7/15/99	7/15/99	Biased sample day due to 3-way gate malfunction during subatch 02, gate stuck in 100% sampling mode (1300-1400).
JDA	99174	9/21/99	9/21/99	Biased sample day due to scheduled dewatering. Samples not taken between approximately 0900-1515.
JDA	99176	9/23/99	9/23/99	Biased sample day because switch-gate was moved to bypass to evaluate hydraulics (1420 - 1650).
JDA	99177	9/24/99	9/24/99	Biased sample day. 3-way sample gate was in by-pass from approx 1350 to 1430. This was done for hydrological testing purposes.
BO1	99005	3/17/99	3/17/99	Fine-tuning of PIT Tag coils not completed until 1700, first sample taken after 1700.
BO1	99019	3/31/99	3/31/99	No sample taken during first 2 hours due to trap maintenance/cable repair.
BO1	99150	8/9/99	8/9/99	No sample taken. Collection channel dewatered due to screen cleaner repairs.

Informational: the wild steelhead noted at Rock Island Dam on end-dates of August 3, 11, 14, 15, 17, 18, 19, 22, and 27 were all fry size.

APPENDIX F

Travel Time Tables

DISTANCES OVER WHICH TRAVEL TIME IS MEASURED:

Snake River Basin Hatcheries		**Distance to Lower Granite Dam**	
Drainage	**Hatchery/Release Site**	**Kilometers**	**Miles**
S.F. Salmon River	McCall H/Knox Bridge	457	284
Salmon River	Rapid River H	283	176
Salmon River	Imnaha A P	209	130
Grand Ronde River	Lookingglass H	238	148
Clearwater River	Dworshak H	116	72

Snake River Basin Traps		**Distance to Lower Granite Dam**	
Drainage	**Trap Location**	**Kilometers**	**Miles**
Salmon River	km 103	233	145
Imnaha River	km 7	142	88
Grande Ronde River	km 5	103	64
Snake River	km 225	52	32

Mid-Columbia River Basin		**Distance to McNary Dam**	
Drainage	**Hatchery**	**Kilometers**	**Miles**
Methow River	Winthrop H	454	282
Wenatchee River	Leavenworth H	330	205
Mainstem Columbia River	Wells H	360	224
Mainstem Columbia River	Priest Rapids H	169	105
Mainstem Columbia River	Ringold H	97	60
Mainstem Columbia River	Hanford Reach(non-hatchery site)	120	75

Key Index Reaches	**Reach Distance**	
Reach Location	**Kilometers**	**Miles**
Lower Granite Dam to McNary Dam	225	140
Rock Island Dam to McNary Dam	260	161
McNary Dam to Bonneville Dam	236	147

Distance Source: Kilometers of sites obtained from 1998 PIT Tag Specification Document, [editor] Carter Stein, Pacific States Marine Fisheries Commission, March 17, 1998. Miles computed using conversion 0.621 miles per kilometer.

Computation of average flow and average temperature: Flow and temperature data are averaged over the period of days equal to the estimated median travel time commencing on the date of release (or date of passage at upstream dam for the Snake River and lower Columbia River index reaches). The flows and temperatures are indexed at Lower Granite Dam for the release to Lower Granite Dam travel time data. They are indexed at Ice Harbor Dam for the Lower Granite Dam to McNary Dam index reach and at The Dalles Dam for McNary Dam to Bonneville Dam index reach. For the release to McNary Dam travel time data of mid-Columbia River basin released fish, the flows and temperatures are indexed at Priest Rapids Dam.

TABLE F-1. 1999 travel time of PIT tagged hatchery chinook and steelhead released from various locations in the Snake River basin to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite Dam	
Release Date	**Min**	**Med**	**Max**	**Lower**	**Upper**	**Number**	**Flow**	**Temp**
	Rapid River Hatchery Chinook							
3/18 - 4/19 *	1.4	37.1	134.8	36.9	37.2	10023	95.7	49.8
	McCall Hatchery Chinook							
4/6 - 4/7	13.8	39.9	129	39.7	40.5	6590	95.5	50.4
	Dworshak Hatchery Chinook							
4/7 - 4/8	4.6	27.7	133.7	27.4	28.2	6706	98.4	44.7
	Imnaha Hatchery Chinook							
3/16 - 4/16 **	5.1	54.7	175.6	54.4	54.9	3489	98	49.4
	Lookingglass Hatchery Chinook							
3/15 - 4/1 ***	9.2	40.4	71.6	40.2	40.6	6935	95.2	48.7
	Dworshak Hatchery Steelhead							
4/26 - 4/30	1.5	6.2	60.1	5.8	6.5	947	115.4	50.8

* Rapid River Hatchery had 33-day volitional release period -- travel time estimates were computed from an April 2 projection of 50% emigration provided by hatchery personnel.
** Imnaha Acclimation Pond had a 32-day volitional release period -- date of 50% emigration was unknown, so travel time estimates were computed from starting day of volitional release period.
*** Lookingglass Hatchery had a 19-day volitional release period -- date of 50% emigration was unknown, so travel time estimates were computed from starting day of volitional release period.

TABLE F-2. 1999 travel time of PIT tagged hatchery chinook released from various locations in the mid-Columbia River basin to McNary Dam.

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
	Winthrop H: Chinook Yearlings							
4/15	9.1	26.4	80.6	25.7	26.9	1276	163	46.9
	Leavenworth H: Chinook Yearlin							
4/19	6.8	27.8	55.7	27.3	28.1	1378	171.1	47.1
	Wells H: Chinook Subyearlings							
6/19	9.6	30.6	65.5	29.6	31.3	369	192.6	59
	Priest Rapids H: Chinook Subye							
6/14	3.8	13	39.6	12	13.6	236	184.7	57.6
6/18	3.2	10.5	34.3	9.7	11.2	250	185.6	57.8
6/23	2.2	11.7	57.2	11	12.2	284	196.3	57.8
	Ringold H: Chinook Subyearling							
6/16	2.9	12	44.4	11.5	12.5	618	183.4	57.8

TABLE F-3. 1999 travel time of PIT tagged wild subyearling chinook released from the Hanford reach in the mid-Columbia River basin to McNary Dam.

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
6/3/99	3.7	32.3	59	29.8	35.5	91	192.4	56.4
6/4/99	2.5	34.7	74.8	31.5	35.6	145	191.5	56.8
6/7/99	5.5	33.1	73.7	29.9	35.7	151	190.5	57.2
6/8/99	2.4	31.8	58.6	30.8	35.1	132	190	57.3
6/9/99	5.3	33.7	57.6	29.9	36.6	78	190.7	57.7
6/10/99	12.1	17.5	35.4	12.1	35.4	3	186.5	57.2

TABLE F-4. 1999 travel time of PIT tagged wild chinook released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/16/99	38	38	38	-	-	1	95	48.6
3/18/99	11.6	19	37.9	11.8	34.7	10	100	48
3/19/99	11	29.1	45.4	13.2	36	22	92.4	48.3
3/20/99	8.6	30.8	62.6	13.1	32.8	30	93.6	48.7
3/21/99	8.2	33.3	65.9	29.3	39.3	28	96.3	48.9
3/22/99	8.6	32.4	63.2	31.3	34.3	49	96.1	49
3/23/99	8.1	35.4	60.1	29.3	47.7	17	97.5	49.2
3/24/99	11.2	30.7	48.6	27.3	38.5	21	95.1	49.2
3/25/99	6.3	17.3	28.4	-	-	2	92.6	48.4
3/29/99	22.1	27.6	36.7	24.4	32.2	14	92.1	49.2
3/30/99	13.2	24.9	56.9	22.8	28.3	30	89.8	49.1
3/31/99	9.2	22.8	49.2	21.8	23.9	38	88.8	49
4/1/99	8.8	21.4	49.4	20.4	23.5	39	87.1	49
4/2/99	12.3	22	37.5	18.6	25.5	28	89.3	48.9
4/6/99	15.4	19.6	29.5	-	-	4	92.4	49.5
4/7/99	7.4	14.4	23.3	12.2	17.2	21	86.3	49.4
4/8/99	10	14.2	20.5	11.9	17.9	14	89.4	49.5
4/9/99	9.4	12.9	15.6	11.5	13.5	15	90.4	49.6
4/12/99	8	11.7	44.3	9.7	14.5	23	97.3	50.2
4/13/99	7.1	10.6	42.2	9.7	11.6	54	99.1	50.4
4/14/99	6.3	10.5	40	8.5	12.4	31	101.7	50.6
4/15/99	5.7	8.6	22.4	7.6	12.1	25	102.8	50.6
4/16/99	5.5	7.6	36.5	6.4	11.8	26	105.3	50.9
4/19/99	3.6	8.5	38.1	6.9	10.7	37	115.8	51.1
4/20/99	4.4	7.6	38.1	6.8	9.1	50	117.7	51
4/21/99	5.5	9.9	34.8	7.4	12.5	35	113.5	50.7
4/22/99	4.9	10.5	17.6	9.5	11.5	31	110.7	50.6
4/23/99	5.4	9.5	29.1	7.5	11.7	21	109.6	50.7
4/26/99	4.6	8.7	14.8	7.4	12.4	9	108.2	50.8
4/27/99	3.7	11.4	34	7.7	14.1	34	104.6	50.9
4/28/99	6.2	11	28.8	7.3	14.4	13	102.1	51
4/30/99	6.5	13.2	25.9	9.4	25.2	16	96.5	51.1
5/3/99	9.8	9.8	9.8	-	-	1	95.5	51.3
5/4/99	8.7	11.2	25	-	-	5	93	51.5
5/5/99	5.7	10.2	17.1	5.7	17.1	7	91.6	51.5
5/6/99	6.6	11.9	24.1	9.4	17	11	88.7	51.7
5/7/99	8.8	9.2	9.5	-	-	2	89	51.6
5/10/99	7.7	8.3	11.9	-	-	5	85.9	51.8
5/11/99	11	13.4	25.4	11	25.4	8	93.6	52.8
5/12/99	6.8	14.6	22.5	-	-	2	109.1	53.4
5/13/99	6.3	13.6	22.1	-	-	6	110.6	53.5
5/14/99	7.5	9.6	13.5	-	-	5	95.3	53.3
5/17/99	5.5	5.5	5.5	-	-	1	95.2	53.6
5/19/99	4.1	7.6	17.4	5.2	15.9	10	128.5	54.6
5/20/99	4.2	6.2	12	4.6	7.6	9	125.7	54.9
5/21/99	4	5.6	6.2	4.1	6	11	139.8	54.9

TABLE F-5. 1999 travel time of PIT tagged hatchery chinook released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/19/99	7.7	44.1	66.7	42.7	45.2	76	98.5	49.3
3/20/99	27.5	40.3	58.3	38.1	43.3	49	98.6	49.2
3/21/99	23.1	41.9	61.2	36.7	45.9	25	99	49.3
3/22/99	29.1	43.7	62.7	39.2	51.3	21	99.3	49.4
3/23/99	25	40.4	58.5	34.6	44.5	27	98.6	49.4
3/24/99	29.2	43.4	60	40.2	46.7	25	98.5	49.6
3/25/99	28.5	39.6	62.5	37.4	44.7	24	98.1	49.5
3/29/99	22.5	35.3	55.7	30.6	41.7	43	95.3	49.5
3/30/99	23.3	38	52.3	29.6	40.8	24	95.3	49.7
3/31/99	23.4	37.8	55.7	31.2	43.5	20	95.2	49.7
4/1/99	20.2	31.2	52.6	25.5	42.6	17	94.4	49.5
4/2/99	24.5	31.7	54.2	27.4	39.8	15	95.4	49.4
4/5/99	16.3	33.6	39.5	-	-	3	96.2	50
4/6/99	24.3	39.7	49.4	27.1	45.5	17	95	50.3
4/7/99	12.9	28.8	40.6	24.5	31.6	61	97.7	50
4/8/99	14.3	28.3	47.9	24.5	31.7	45	98.4	50.1
4/9/99	22.2	31.2	46.3	25	36.1	22	98.7	50.4
4/12/99	9.8	25	39.5	20.5	28.7	26	101.8	50.5
4/13/99	16	26.2	44	24.3	30.6	36	102.3	50.7
4/14/99	9	24.4	39.6	14.1	28.7	23	103.5	50.8
4/15/99	7.2	20.2	40.1	15.6	27.4	20	105.8	50.7
4/16/99	7.9	22.6	41.2	18.2	29.9	15	105	51
4/19/99	5.7	20.7	36.8	18.3	24.5	42	107.1	51.1
4/20/99	9.6	22.3	37	19.4	25.3	51	105.8	51
4/21/99	12.5	22.5	34.3	16.6	25.6	23	103.7	51
4/22/99	7.8	21.4	33.2	17.6	25.6	21	103.4	51
4/23/99	8.6	16.7	33.2	15.1	22.9	19	105	51
4/26/99	5.6	13.8	33.3	12.6	17.4	34	103.8	51.1
4/27/99	5.9	18.1	29.4	15.1	22.8	36	98.7	51.2
4/28/99	11	22.4	28.3	18.5	23.7	28	94.6	51.5
4/30/99	12.5	20.4	26.2	15.6	24.1	16	92.6	51.6
5/3/99	8	16.8	26.1	14.3	20.2	24	91.3	51.8
5/4/99	8.7	18	26.8	17.1	19.7	29	92	52.1
5/5/99	7.6	17.5	20.4	12.5	18.7	18	92.4	52.3
5/6/99	8.2	17.7	19.3	12.7	18.9	19	94	52.5
5/7/99	8.6	16	21.9	13.6	18.5	17	91.5	52.4
5/10/99	6.5	9.5	12.7	-	-	3	86.5	52.1
5/11/99	7.3	12.6	17.2	11.1	15.3	14	93.6	52.8
5/12/99	8.3	10.8	14.2	8.4	13.3	10	90.9	52.8
5/13/99	8.2	10.6	13.5	8.5	12.1	16	94.6	53.1
5/14/99	8.6	9.3	12	-	-	5	91.7	53.1
5/17/99	7.2	9.1	10	-	-	5	113.4	54.2
5/18/99	4.7	5.3	8.9	-	-	5	97.3	53.8
5/19/99	4.3	5.6	7	4.9	6.1	12	112.5	54.4
5/20/99	4.6	6.1	10.5	5.1	6.8	21	125.7	54.9
5/21/99	4.1	5.1	9.1	4.9	6.1	29	131.9	55

TABLE F-6. 1999 travel time of PIT tagged wild steelhead released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/15/99	4.5	4.5	4.5	-	-	1	92.7	50.5
4/16/99	3.8	3.8	3.8	-	-	1	95.3	51
4/20/99	3	3.4	4.3	-	-	4	121.5	51
4/21/99	3.6	3.6	3.6	-	-	1	116.4	50.8
4/22/99	3.3	4.7	6.4	3.4	5.7	11	115.4	50.6
4/23/99	3.5	14.8	26.1	-	-	2	106.4	50.9
4/26/99	2.9	3.5	6.1	-	-	3	113.6	50.8
4/28/99	2.9	4.7	26.1	-	-	5	106	50.7
4/30/99	3	4.2	6.1	3.4	5	14	102.8	50.5
5/4/99	4.2	4.2	4.2	-	-	1	99.1	51.2
5/6/99	4.1	4.1	4.1	-	-	1	95	51.6
5/7/99	5.8	5.8	5.8	-	-	1	91.2	51.4
5/11/99	4.8	4.8	4.8	-	-	1	85.5	51.5
5/14/99	4.4	4.4	4.4	-	-	1	83.2	52.2
5/18/99	3.4	4.2	5	-	-	2	93.6	53.6
5/20/99	4.1	4.1	4.1	-	-	1	108.8	54.4
5/21/99	2.7	3.2	6.8	-	-	6	113.8	54.5

TABLE F-7. 1999 travel time of PIT tagged hatchery steelhead released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/14/99	4.5	16.6	32.3	-	-	5	104.8	50.6
4/15/99	5.8	8.3	32	7	15.7	12	102.7	50.6
4/16/99	3.9	7.6	36.6	5.5	12.6	25	105.3	50.9
4/19/99	3	4.2	35.1	3.6	5.7	33	116.9	51.2
4/20/99	3	4.8	37.6	3.2	22.5	16	116.8	51
4/21/99	4.9	10.6	29.2	-	-	5	112.6	50.7
4/22/99	3.2	9.5	29.1	4.6	18	13	111.3	50.6
4/23/99	3.5	5.6	9	4.5	8.4	9	114.4	50.8
4/26/99	3.3	8.9	32.6	3.3	26.8	10	108.2	50.8
4/27/99	3	5.1	7.9	3	7.9	8	109.2	50.7
4/28/99	3	4.8	32.6	3.8	8.4	29	106	50.7
4/30/99	2.9	5.4	29.6	4.6	6.9	90	102.4	50.6
5/3/99	2.8	5.3	24.1	4.3	7.4	13	99.9	51.2
5/4/99	3.3	5.1	18.2	3.6	7.8	19	98.2	51.4
5/5/99	3	4.7	20.7	3.8	7.4	29	96	51.5
5/6/99	3.1	6.4	22.6	5.5	7.4	59	92.9	51.4
5/7/99	2.9	6.4	19	5.8	9.5	37	91.2	51.4
5/10/99	3.3	6.4	15.6	4.4	10.6	38	86.9	51.6
5/11/99	3.3	7	26.9	5.3	10.2	49	84.7	51.8
5/12/99	3.3	6	13.8	4.2	10.6	22	84.2	51.9
5/13/99	4.4	6.7	15.6	5.4	12.6	13	85	52.4
5/14/99	4.4	8	15.6	4.6	10.1	18	89	52.9
5/17/99	3.5	5.6	19.7	4.7	7	30	95.2	53.6
5/18/99	3	4.3	12.9	3.8	5.9	27	93.6	53.6
5/19/99	3	5.1	17	4.8	5.8	59	105.5	54.2
5/20/99	2.4	4.3	11.8	3.9	5.6	27	108.8	54.4
5/21/99	3.1	3.9	12.4	3.6	4.6	21	122	54.8

TABLE F-8. 1999 travel time of PIT tagged wild chinook released from the Salmon River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/22/99	4.7	9.6	29.1	6.6	15.7	15	111	49.4
3/23/99	4	10	26.6	7.9	17.1	20	108.5	49.3
3/24/99	6	14.2	28.3	9.4	19	18	98.7	48.5
3/25/99	4	8.2	26.2	7.2	18.2	25	107	49.7
3/26/99	3.8	8	25	5.3	17.4	20	104.5	49.5
3/29/99	8.9	10.7	20.8	8.9	20.8	7	86.1	48
3/30/99	6.3	10.6	22.7	6.8	21.7	12	83.1	48
3/31/99	6.9	14.2	31.4	6.9	31.4	8	80.5	48
4/1/99	6.7	13.2	20.8	6.7	20.8	7	79.4	48
4/2/99	8.8	12.5	28.1	10.7	17.5	12	79.1	47.5
4/5/99	5.4	11.6	46.1	9.1	13.3	42	78.2	48.2
4/6/99	6.3	13.1	14.9	11.3	14	15	80.4	48.8
4/7/99	6.1	11.6	13.1	6.5	12.6	9	80.7	48.9
4/8/99	4.5	7.2	11.1	4.5	11.1	8	76.9	48
4/9/99	5.1	9.3	12.8	5.3	10.4	13	80	48.8
4/12/99	6.2	8	21.5	7.1	8.8	16	88.1	49.9
4/13/99	5.3	6.9	10.3	6.2	7.9	14	89.7	50.1
4/14/99	4.7	7.1	11.8	6.8	8.1	15	95.6	50.7
4/15/99	3.9	6.5	8	-	-	5	100.7	50.6
4/16/99	2.8	5.3	9.8	3.3	6	17	100.4	51.2
4/19/99	2	3.7	12.6	3.3	4	63	116.9	51.2
4/20/99	1.9	4.8	10.5	3.8	5.8	36	116.8	51
4/21/99	2.1	4.4	11	3.9	6	34	116.4	50.8
4/22/99	3.8	6	10.3	4.3	7.9	21	116.4	50.7
4/23/99	2.4	4.8	20.4	4	5.6	26	115.4	50.8
4/26/99	2.2	5.1	16	4.1	7.2	23	111.1	50.7
4/27/99	1.4	4.8	20.8	4.2	5.5	75	109.2	50.7
4/28/99	2	4.3	12.4	3.5	5	37	106.4	50.6
4/29/99	2.5	4.2	11.9	3.7	5	30	102.8	50.6
4/30/99	3	4.4	7.3	3.6	5.5	17	102.8	50.5
5/3/99	2.4	5	7.2	4.1	5.3	18	99.9	51.2
5/4/99	2.7	4.9	11.2	4	6.4	18	98.2	51.4
5/5/99	2.3	4	7.5	3.3	5.1	22	96	51.4
5/6/99	1.8	3.8	11	2.9	9.4	10	95	51.6
5/7/99	3.3	4.9	9.8	3.4	7.3	9	92	51.5
5/10/99	4.4	7.6	17.2	-	-	5	85.9	51.8
5/11/99	4.2	10	15.7	-	-	2	86.3	52.3
5/12/99	4.2	5.6	6.9	-	-	4	84.2	51.9
5/14/99	4.2	4.2	4.2	-	-	1	83.2	52.2
5/17/99	3.3	4	4.8	-	-	2	87.4	53.2
5/19/99	1.9	1.9	1.9	-	-	1	90.7	53.7
5/20/99	2.1	3.4	4.7	-	-	2	103.2	54.2
5/21/99	1.9	2.3	2.8	-	-	4	107.9	54.3
5/22/99	1.8	2.9	4.5	2.1	3.2	19	128.9	55
5/23/99	1.8	2.7	7.8	2.5	3.6	27	145.8	55.5
5/24/99	1.6	3.1	9.7	2.6	3.6	30	163.7	55.2
5/25/99	1.4	2.7	7.7	2.3	3.3	52	171.2	55

TABLE F-9. 1999 travel time of PIT tagged hatchery chinook released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/22/99	5.7	9.8	31.4	5.7	31.4	7	111	49.4
3/23/99	3.2	33.8	40.9	4.4	40.3	10	96.8	49.2
3/24/99	7.8	26.2	29.7	9.9	29.6	9	90.9	48.8
3/25/99	6.4	28.2	47.3	8.6	38.8	11	93.4	49.1
3/26/99	5.8	14.2	44.4	-	-	5	93.7	48.5
3/29/99	2.3	5	23.8	2.3	23.8	7	94.7	49
3/30/99	2.4	3.3	23.2	-	-	5	91.6	50
3/31/99	2.3	6	16.8	-	-	4	85.2	48
4/1/99	3	6.7	13.8	-	-	3	81.4	48
4/2/99	6.1	15.6	27.8	6.1	27.8	8	80.4	48.1
4/5/99	6.6	15.9	30.2	14.6	20	25	85.3	49.1
4/6/99	11.7	15.9	29.6	11.7	29.6	7	87.8	49.2
4/7/99	6.4	11.8	35	9.6	13.8	17	80.7	48.9
4/8/99	8.9	15.2	30.3	11.6	19.8	13	91.2	49.5
4/9/99	8.3	12.8	16.2	8.3	16.2	7	90.4	49.6
4/12/99	3	9.9	28.9	8.5	12.6	33	94.7	50.1
4/13/99	4.5	9.2	26.2	8.8	12	19	96.7	50.3
4/14/99	4.6	8.9	24.2	7	11.7	29	100.6	50.6
4/15/99	3	7	22.7	6.8	9	45	100.7	50.6
4/16/99	3.4	6.6	23.3	5.6	9	42	105.5	50.9
4/19/99	2.2	5.6	91.1	4.9	6.5	63	114.2	51.2
4/20/99	2.1	5.2	18.5	4.2	7.1	19	116.8	51
4/21/99	2	6.5	18.1	5	10.1	32	117.6	50.9
4/22/99	2.8	6	12.9	4.1	9.4	29	116.4	50.7
4/23/99	3	5.3	16.8	4.3	6.9	33	115.4	50.8
4/26/99	2.1	5.6	19.8	4.5	6.4	56	109.8	50.7
4/27/99	1.9	5.2	15.1	4.1	6.3	32	109.2	50.7
4/28/99	2.2	5.8	15.4	5.1	8	31	106.4	50.7
4/29/99	2.2	4.7	17.7	4	6.8	27	103.8	50.6
4/30/99	2.2	4.3	11.1	3.8	6.9	33	102.8	50.5
5/3/99	2.1	5	16.5	4.6	5.8	56	99.9	51.2
5/4/99	3	5	12.3	4.2	5.3	25	98.2	51.4
5/5/99	2.8	5.4	14.8	3.9	7	22	96	51.5
5/6/99	2.6	6.2	10.1	5	7.2	26	92.9	51.4
5/7/99	3	5.8	14.3	5.1	8.8	28	91.2	51.4
5/10/99	3.5	6.5	9.5	4.3	7.7	17	86.4	51.6
5/11/99	3	5.4	9.3	3.3	8.5	12	85.5	51.5
5/12/99	2.7	4.2	9.6	-	-	6	84.9	51.6
5/13/99	2.9	4.3	10.3	2.9	6.8	9	84	51.8
5/14/99	3.9	4.5	4.9	-	-	3	84.1	52.3
5/17/99	2.1	3.6	5.8	-	-	6	87.4	53.2
5/18/99	1.8	3	4.9	2.2	3.9	14	88.6	53.5
5/19/99	1.9	3	3.6	-	-	6	96.4	53.8
5/20/99	1.4	2.1	2.8	1.9	2.5	22	99	54
5/21/99	1.5	2.3	6.4	2.1	2.6	40	107.9	54.3
5/22/99	1.6	2.7	4.4	2.2	2.8	20	128.9	55
5/23/99	1.6	2.5	4.8	2	2.7	41	145.8	55.5
5/24/99	1.4	2.6	7.4	1.8	2.8	18	163.7	55.2
5/25/99	1.2	2.5	6.7	1.8	3.4	36	171.2	55

TABLE F-10. 1999 travel time of PIT tagged wild steelhead released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/24/99	4.1	4.1	4.1	-	-	1	119.2	49.5
3/26/99	2	8.4	18.4	-	-	3	104.5	49.5
3/29/99	1.8	2	21.5	-	-	4	102.6	0
4/5/99	14.8	23.5	32.2	-	-	2	95	49.6
4/12/99	4.6	4.6	4.6	-	-	1	80.9	48.8
4/16/99	2.4	3.6	4.9	-	-	2	95.3	51
4/19/99	1.4	2	5	1.7	3.5	12	114.4	52
4/20/99	1.2	1.8	3.2	1.3	2.3	16	122.5	51.3
4/21/99	1.4	1.6	2.8	1.5	1.9	16	122.5	50.7
4/22/99	1.4	1.7	15.2	1.5	2.4	14	115	50.3
4/23/99	1.6	2	4.4	1.7	3	10	111.1	50.5
4/26/99	1.3	1.3	1.9	-	-	3	118.5	51
4/27/99	1.3	1.7	3.7	1.5	2.7	10	118	51
4/28/99	1.7	2	3.2	1.7	2.5	10	110.3	50.7
4/29/99	1.7	2	2.8	1.7	2.7	10	102.6	50.3
4/30/99	1.9	2.1	4.7	-	-	6	100.4	50.3
5/3/99	1.4	1.6	2.2	1.4	2.2	8	104.5	51
5/4/99	2.1	2.1	2.1	-	-	1	102.6	51
5/5/99	2	2.4	2.7	2.2	2.6	9	97	51
5/6/99	2.5	2.5	2.5	-	-	1	94.8	51.5
5/7/99	1.7	1.7	2.1	-	-	4	93.7	51.7
5/10/99	2.4	2.7	10.2	2.4	10.2	7	89.4	51.2
5/12/99	2.5	2.5	2.7	-	-	3	85.8	51.5
5/13/99	1.9	2.4	3.3	1.9	3.3	7	85.4	51.7
5/14/99	4.5	4.5	4.5	-	-	1	84.1	52.3
5/17/99	2.1	2.8	3.6	-	-	5	85.6	53
5/18/99	2	2.2	2.3	-	-	2	86.6	53.3
5/19/99	1.7	1.8	2.9	-	-	6	90.7	53.7
5/20/99	1.5	1.8	4.2	1.6	2.2	19	99	54
5/21/99	1.4	1.8	3.6	1.5	2.6	14	107.9	54.3
5/22/99	1.5	1.8	7.3	1.7	2.4	21	120.3	54.7
5/23/99	1.5	1.6	2.3	1.5	1.8	11	134	55.3
5/24/99	1.2	1.5	2.8	1.3	1.5	17	155.8	55.7
5/25/99	1.1	1.4	1.5	-	-	4	168	56

TABLE F-11. 1999 travel time of PIT tagged hatchery steelhead released from the Snake River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/5/99	1.9	3.1	15.2	-	-	6	76.7	47.5
4/6/99	3.2	5.4	28.9	-	-	6	75.2	47.8
4/7/99	2.5	3.6	17.6	2.5	17.6	8	74.9	48
4/8/99	3.3	4	23.1	-	-	5	74.8	48
4/9/99	3	4	4.4	3	4.4	7	75.8	48
4/12/99	2	3.4	19.6	2.4	6.9	22	79.2	48
4/13/99	2.2	2.2	4.9	-	-	3	80.5	48
4/14/99	2.1	4.1	16.8	2.1	16.8	7	84.2	49.8
4/15/99	2.3	3	12.8	-	-	5	84.9	49.8
4/16/99	2	2.6	4.8	-	-	6	89.4	50.8
4/19/99	1.2	1.8	9.6	1.8	2.2	30	114.4	52
4/20/99	1.1	1.8	32.4	1.6	1.9	94	122.5	51.3
4/21/99	1.2	1.6	35.7	1.5	1.8	59	122.5	50.7
4/22/99	1.2	1.5	33.9	1.4	1.9	37	115	50.3
4/23/99	1.4	2.1	36.6	2	2.4	38	111.1	50.5
4/26/99	1.2	1.6	3.8	1.4	1.8	22	119.6	51
4/27/99	1	1.5	24.2	1.4	1.6	65	118	51
4/28/99	1.2	1.8	26.4	1.6	1.9	73	110.3	50.7
4/29/99	1.6	2	13.2	1.9	2.1	33	102.6	50.3
4/30/99	1.5	1.9	3.9	1.8	2	28	100.4	50.3
5/3/99	1.2	1.4	5.9	1.4	1.6	45	106.5	51
5/4/99	1.4	2.1	15.2	1.9	2.4	32	102.6	51
5/5/99	1.6	2.1	17.1	2.1	2.2	53	97	51
5/6/99	1.4	1.8	18	1.7	1.9	32	95.3	51.3
5/7/99	1.3	1.9	5.4	1.9	2.1	25	93.7	51.7
5/10/99	2.2	2.9	11.6	2.5	3.3	34	89.4	51.2
5/11/99	1.8	2.1	10.9	2	2.4	23	87.3	51
5/12/99	1.2	2.2	9.4	1.9	5.9	19	86.7	51.3
5/13/99	1.9	2.2	3.2	2.1	2.3	30	85.4	51.7
5/14/99	1.5	1.9	2.9	1.8	2.1	12	83.6	52
5/17/99	1.5	2.3	8.2	2.1	2.6	43	84.6	52.7
5/18/99	1.6	2.2	10	2.1	2.6	20	86.6	53.3
5/19/99	1.5	1.9	3.2	1.8	2.3	27	90.7	53.7
5/20/99	1.5	2	3.8	1.6	2.6	17	99	54
5/21/99	1.4	1.9	9.4	1.8	2.3	49	107.9	54.3
5/22/99	1.4	1.8	10.1	1.6	2	30	120.3	54.7
5/23/99	1.4	1.7	16.1	1.6	1.8	61	134	55.3
5/24/99	1.2	1.5	10.1	1.5	1.6	38	155.8	55.7
5/25/99	0.9	1.3	5.4	1.2	1.4	48	168	56

TABLE F-12. 1999 travel time of PIT tagged wild chinook released from the Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/15/99	2.6	25	97.5	12.8	35.8	96	103.7	50.9
4/16/99	3.2	11.2	97.3	7.8	17	124	107.9	50.9
4/17/99	1.7	7.6	65.3	5.8	16.4	112	108.4	51
4/18/99	2.9	3.9	17.6	-	-	5	111.3	51.4
4/19/99	2.1	4.6	37.2	2.8	23	18	114.7	51.2
4/20/99	2.2	11.5	37.1	2.4	30.4	13	113	50.8
4/21/99	2	11.4	42.2	2.9	21.2	20	112.6	50.7
4/22/99	1.8	31	41.4	20.5	32.5	31	99.8	51.7
4/23/99	3.1	28	54.1	8.9	31	32	97.9	51.5
4/24/99	4.6	16.2	28.9	-	-	4	104.2	51.1
4/27/99	2.3	17.2	31.6	2.4	26.2	11	99.6	51.1
4/28/99	4.8	23.4	32.2	5.7	27.6	10	94.6	51.7
4/29/99	2.4	22.1	47.2	7.3	25.7	16	93.4	51.7
4/30/99	2.5	8.9	27.1	4.3	24.4	17	99.4	51
5/3/99	1.9	6.3	22.5	2.5	20.5	9	99	51.3
5/4/99	2.7	6.8	20.7	3.1	20	10	96.6	51.4
5/5/99	2.7	15.6	18.9	4.7	17.5	13	89.7	52
5/6/99	14.1	16.2	25.7	-	-	3	90.5	52.2
5/7/99	2.3	4.2	14.1	-	-	5	93.1	51.6
5/10/99	4.3	11.7	15.9	7.1	12.6	13	89.2	52.4
5/11/99	3	10	38.4	9.8	10.9	72	86.3	52.3
5/12/99	2.2	8.7	17	7.5	9.3	39	86.1	52.4
5/13/99	2.7	7.9	19.8	7.5	8.3	58	86	52.6
5/14/99	3.2	7.3	14.4	6.8	8	27	86	52.8
5/17/99	2.9	4.4	60.8	4	5.6	36	87.4	53.2
5/18/99	2.2	3.8	11.1	3.6	4.2	68	93.6	53.6
5/19/99	1.5	4.8	29.6	4.4	5.4	425	105.5	54.2
5/20/99	2.6	5.3	18.9	4.6	6.5	39	116.5	54.7
6/2/99	0.5	2	53.9	1.5	3.6	33	162.8	54
6/3/99	0.8	2.7	15.1	2.2	11.2	30	153.1	53.2
6/4/99	0.7	3.2	15.7	2.1	10.8	41	147.3	53.2
6/5/99	1.2	2.6	11.9	1.6	10.1	12	143.6	53.5
6/7/99	1.5	8	13.6	6	8.6	50	122.1	55.6
6/8/99	1.6	7.3	11.5	6.1	8.1	47	120.1	55.9
6/9/99	1.5	6.8	50.8	6.3	7.1	91	121.3	56.6
6/10/99	1.9	4.7	11.5	4.1	5.3	43	115.5	56.6
6/11/99	2.5	4.5	8.4	3.6	4.8	31	120.4	57.6
6/14/99	2	2.4	6.5	2.1	3.2	27	132.6	58.3
6/15/99	1.3	2.4	6.7	2	2.5	95	145	58.7
6/16/99	1.7	2.2	7.7	1.8	2.6	26	153.7	59
6/17/99	1	1.9	23.3	1.5	1.9	32	159.7	59
6/18/99	1.2	1.6	27.8	1.4	2	32	161.9	59
6/21/99	0.9	2.1	38.6	1.3	4	20	143.1	59
6/22/99	1.5	2.6	27.7	2.1	23.3	16	129.9	59
6/23/99	2.2	4.7	24.1	2.2	23.3	9	116.3	59
6/24/99	1.7	4.2	41.7	1.7	41.7	8	112.9	59

TABLE F-13. 1999 travel of PIT tagged hatchery chinook released from the Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/20/99	31.2	40.6	42.8	-	-	4	98.7	49.2
4/7/99	14.9	25.8	39.6	24.1	27.6	97	97.1	49.9
4/10/99	18.7	24.1	34.5	22.2	28	29	100.2	50.2
4/11/99	9.5	27	131.4	24.6	29.2	55	100.6	50.4
4/12/99	17.8	21.8	25.7	-	-	2	102.5	50.4
4/13/99	5.1	22.8	133.4	20.6	25.6	68	103.4	50.6
4/15/99	6.8	10.2	13.5	-	-	2	103.5	50.6
4/21/99	7.9	22.8	26.6	7.9	26.6	8	103.7	51
4/24/99	10	25.6	28.8	-	-	5	97.3	51.5
5/12/99	13.3	13.3	13.3	-	-	1	98.3	53.1

TABLE F-14. 1999 travel of PIT tagged wild steelhead released from the Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/1/99	47.7	47.7	47.7	-	-	1	93.4	50.3
4/4/99	15.7	15.7	15.7	-	-	1	82.8	48.8
4/5/99	13.8	13.8	13.8	-	-	1	80.4	48.6
4/6/99	34.6	34.6	34.6	-	-	1	96.5	50.2
4/12/99	16.8	16.8	16.8	-	-	1	102.4	50.4
4/13/99	8.7	8.7	8.7	-	-	1	96.7	50.3
4/15/99	4.9	8.7	23.7	-	-	3	102.8	50.6
4/16/99	3.9	12.3	15.8	-	-	3	109	50.9
4/17/99	1.8	3.2	15.8	1.8	15.8	8	98.3	51.2
4/18/99	2.5	3.6	4.8	-	-	6	111.3	51.4
4/19/99	2.7	3.4	4.2	-	-	4	116.4	51.5
4/20/99	2.5	4.1	11.3	-	-	6	118	51
4/21/99	2	5	10.4	2.6	7.5	12	116	50.8
4/22/99	2.9	5.9	14.3	3.2	12.7	11	116.4	50.7
4/23/99	3	4.4	7.9	4	6	18	114	50.8
4/24/99	2.2	4	16.1	2.9	5.6	15	114.7	51
4/27/99	1.8	4	25.5	2.3	6.2	17	110.6	50.6
4/28/99	1.8	2.6	5.8	2	5.4	10	107.4	50.5
4/29/99	2.9	5.1	24.8	4.2	10.7	17	103.8	50.6
4/30/99	3.6	4.7	6.7	3.8	6	10	102.4	50.6
5/3/99	2.5	3.9	19.4	3	6.7	19	100.8	51
5/4/99	2.4	3.8	20.8	3	5.7	15	99.1	51.2
5/5/99	2.3	6.6	28.7	2.8	11	11	93.9	51.4
5/6/99	2.3	3.4	8.4	3	5.4	18	94.8	51.5
5/7/99	2.9	4.3	15.6	3.3	5.6	19	93.1	51.6
5/10/99	2.8	5.4	13.4	3.7	12.7	10	87.9	51.5
5/11/99	2.8	4.9	13.9	4.1	6.2	39	85.5	51.5
5/12/99	2.5	4.7	13.4	3.5	5.5	46	84.5	51.7
5/13/99	2.4	5.1	11.3	4.4	5.8	59	83.7	52
5/14/99	3.3	6.9	8.5	4.2	7.4	21	86	52.8
5/17/99	2.8	4.2	7.8	3.9	4.5	51	87.4	53.2
5/18/99	2.5	3.6	6.4	3.2	3.7	44	93.6	53.6
5/19/99	1.8	3.5	11.3	3.2	3.9	74	100.3	54
5/20/99	2.6	3.2	4.3	2.7	3.7	10	103.2	54.2
6/2/99	1.3	2.6	6	-	-	3	160.1	53.8
6/3/99	1.3	2.9	6.7	1.3	6.7	8	153.1	53.2
6/4/99	1	2.2	10.8	1.2	2.9	9	150.2	53
6/5/99	1.3	2	5.6	-	-	6	145.5	53.3
6/7/99	1.7	3.3	9	2	9	11	131.1	54
6/8/99	2.3	6.2	7.7	-	-	5	118.5	55.5
6/9/99	2	6.4	8.3	4	8	10	117.6	56.2
6/10/99	3	3	3	-	-	1	110.7	55.7
6/11/99	2.7	3.2	3.6	-	-	3	110.9	57
6/14/99	2.3	3	3.7	-	-	2	138.5	58.5
6/15/99	1.4	2.6	4.6	-	-	6	148.1	58.8
6/16/99	2.4	3.4	4.5	-	-	2	156.7	59
6/23/99	2.5	2.5	2.5	-	-	1	123.7	59

TABLE F-15. 1999 travel of PIT tagged hatchery steelhead released from the Imnaha River trap to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/15/99	2.6	25	97.5	12.8	35.1	96	103.7	50.9
4/16/99	3.2	11.2	97.3	7.8	16.7	124	107.9	50.9
4/17/99	1.7	7.6	65.3	5.8	14.9	112	108.4	51
4/18/99	2.9	3.9	17.6	2.9	17.6	5	111.3	51.4
4/19/99	2.1	4.6	37.2	2.8	9	18	114.7	51.2
4/20/99	2.2	11.5	37.1	2.3	17.9	13	113	50.8
4/21/99	2	11.4	42.2	2.9	21	20	112.6	50.7
4/22/99	1.8	31	41.4	20.5	31.6	31	99.8	51.7
4/23/99	3.1	28	54.1	8.9	30.4	32	97.9	51.5
4/24/99	4.6	16.2	28.9	4.6	28.9	4	104.2	51.1
4/27/99	2.3	17.2	31.6	2.4	24.2	11	99.6	51.1
4/28/99	4.8	23.4	32.2	5.7	26.6	10	94.6	51.7
4/29/99	2.4	22.1	47.2	7.3	25	16	93.4	51.7
4/30/99	2.5	8.9	27.1	4.3	22.6	17	99.4	51
5/3/99	1.9	6.3	22.5	1.9	6.6	9	99	51.3
5/4/99	2.7	6.8	20.7	3.1	17.9	10	96.6	51.4
5/5/99	2.7	15.6	18.9	3.6	16.3	13	89.7	52
5/6/99	14.1	16.2	25.7	14.1	25.7	3	90.5	52.2
5/7/99	2.3	4.2	14.1	2.3	14.1	5	93.1	51.6
5/10/99	4.3	11.7	15.9	5.3	12.3	13	89.2	52.4
5/11/99	3	10	38.4	9.8	10.7	72	86.3	52.3
5/12/99	2.2	8.7	17	7.5	9.1	39	86.1	52.4
5/13/99	2.7	7.9	19.8	7.5	8.3	58	86	52.6
5/14/99	3.2	7.3	14.4	6.8	7.8	27	86	52.8
5/17/99	2.9	4.4	60.8	4	5.6	36	87.4	53.2
5/18/99	2.2	3.8	11.1	3.6	4.1	68	93.6	53.6
5/19/99	1.5	4.8	29.6	4.4	5.3	425	105.5	54.2
5/20/99	2.6	5.3	18.9	4.6	5.8	39	116.5	54.7
6/2/99	0.5	2	53.9	1.4	3.6	33	162.8	54
6/3/99	0.8	2.7	15.1	2.2	10.9	30	153.1	53.2
6/4/99	0.7	3.2	15.7	2.1	10.2	41	147.3	53.2
6/5/99	1.2	2.6	11.9	1.6	5.2	12	143.6	53.5
6/7/99	1.5	8	13.6	6	8.4	50	122.1	55.6
6/8/99	1.6	7.3	11.5	5.7	8.1	47	120.1	55.9
6/9/99	1.5	6.8	50.8	6.3	7.1	91	121.3	56.6
6/10/99	1.9	4.7	11.5	4.1	5.1	43	115.5	56.6
6/11/99	2.5	4.5	8.4	3.6	4.7	31	120.4	57.6
6/14/99	2	2.4	6.5	2.1	3	27	132.6	58.3
6/15/99	1.3	2.4	6.7	2	2.5	95	145	58.7
6/16/99	1.7	2.2	7.7	1.8	2.6	26	153.7	59
6/17/99	1	1.9	23.3	1.5	1.9	32	159.7	59
6/18/99	1.2	1.6	27.8	1.4	2	32	161.9	59
6/21/99	0.9	2.1	38.6	1.3	3.1	20	143.1	59
6/22/99	1.5	2.6	27.7	2.1	14.2	16	129.9	59
6/23/99	2.2	4.7	24.1	2.2	8.3	9	116.3	59
6/24/99	1.7	4.2	41.7	1.7	35.2	8	112.9	59

TABLE F-16. 1999 travel of PIT tagged wild chinook release from the Grande Ronde River to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/10/99	70.1	70.1	70.1	-	-	1	94.5	49.6
3/18/99	20.5	25.8	31	-	-	2	93.6	48
3/19/99	10.4	14.5	20.9	-	-	4	104.5	48.6
3/22/99	8.1	25.8	30.9	-	-	5	92.4	48.4
3/23/99	8.5	17.1	37.2	8.5	37.2	8	97.1	48.4
3/24/99	4.4	16.8	29.2	-	-	2	94.8	48.4
3/25/99	7.7	23.6	33.9	7.7	33.9	7	89.7	48.6
3/26/99	5	11.7	19.3	-	-	5	96.7	48.6
3/29/99	23.9	23.9	23.9	-	-	1	89	49
3/30/99	6.3	20.1	22	7	21.9	9	83.1	48.6
3/31/99	6.4	17.5	24.9	6.4	24.9	8	81.4	48.4
4/1/99	9.1	19.6	29.6	-	-	6	85.5	49
4/2/99	6.4	17.6	32.8	13.1	20.9	9	83.3	48.5
4/5/99	13.2	14.8	16.3	-	-	2	82.8	48.9
4/6/99	13.8	13.8	13.8	-	-	1	83	49
4/7/99	13.2	14.9	15.8	-	-	4	88.5	49.4
4/8/99	10.8	11.3	12.9	-	-	5	81.1	49
4/9/99	8.8	10.8	12.8	-	-	5	84.8	49.4
4/12/99	6.7	11	14.2	-	-	4	96.7	50.1
4/13/99	6.2	9.9	14.1	-	-	3	98.7	50.3
4/14/99	4.7	7.5	22.8	5.3	12.5	12	98.6	50.6
4/15/99	4.3	7.2	12.8	6.3	9.9	18	100.7	50.6
4/16/99	5.9	7.5	23	-	-	6	105.3	50.9
4/19/99	1.8	8	15.8	5.9	10	15	115.1	51.1
4/20/99	3.5	7	14.1	6.2	8.6	26	117.2	51
4/21/99	4.7	7.5	9.4	4.7	9.4	7	116.6	50.9
4/22/99	4.3	8.4	20	5.7	11.7	12	113.7	50.6
4/23/99	3.1	6.5	16.7	4.7	10.8	18	112.7	50.7
4/26/99	2.9	6.8	14.5	2.9	14.5	7	109.1	50.8
4/27/99	3.8	5.6	10.3	4.2	6.7	9	108.4	50.7
4/28/99	4	8.2	14.8	-	-	6	104.9	50.8
4/29/99	4.2	7.5	8.9	-	-	4	101.5	50.8
4/30/99	3.2	5.3	9.8	3.2	9.8	7	102.4	50.6
5/3/99	6.8	8.4	10	-	-	2	97.4	51.4
5/4/99	4.8	6.9	14.9	4.8	14.9	7	96.6	51.4
5/5/99	4.6	7.3	12	-	-	5	93.9	51.4
5/6/99	3.1	4.8	6.8	-	-	3	93.9	51.5
5/7/99	2.8	6.1	9.3	2.8	9.3	7	91.2	51.4
5/10/99	4.4	5.6	6.1	-	-	4	86.9	51.6
5/11/99	4.3	5.8	11.2	4.4	11.2	10	85.1	51.6
5/12/99	4	4.9	5.8	-	-	2	84.5	51.7
5/14/99	6.7	6.7	6.7	-	-	1	86	52.8
5/17/99	4.3	4.3	4.3	-	-	1	87.4	53.2
5/18/99	4.8	5.2	5.7	-	-	2	97.3	53.8
5/19/99	3	4	4.9	3.1	4.7	9	100.3	54
5/20/99	2.8	3.7	5.7	3.4	5.4	16	108.8	54.4
5/21/99	2.6	4.2	6.1	3.4	4.9	13	122	54.8
5/24/99	1.4	2.9	4.5	2.1	3.6	17	163.7	55.2
5/25/99	1.8	2.7	5.6	2.4	4.4	12	171.2	55

TABLE F-17. 1999 travel of PIT tagged hatchery chinook release from the Grande Ronde River to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/17/99	17	35.9	43.6	34.2	38.3	43	94.6	48.6
3/18/99	7.3	34.3	44.2	32.7	35.8	46	94.1	48.7
3/22/99	4.8	30.2	44.2	11.8	32.6	23	94.5	48.9
3/23/99	3.4	15.8	37.1	4.8	29.6	26	98.4	48.4
3/24/99	2.4	22.6	30.8	2.4	30.8	8	90.8	48.4
3/25/99	25.9	27.8	34.2	25.9	34.2	7	93.4	49.1
3/26/99	3.5	6.3	26.1	3.5	26.1	7	109.4	51
3/29/99	3.3	26.3	35.7	22.8	28.8	12	90.6	49.1
3/30/99	21.4	25.3	35.9	21.8	33.4	14	89.8	49.1
3/31/99	17.5	23.8	37	21.3	28.4	10	89.4	49.1
4/1/99	9.7	25.4	34	22.4	28.3	27	90.9	49.2
4/2/99	14.4	24.9	36.2	21.1	26.8	38	92.4	49.1
4/5/99	9.2	18.6	33.8	15	24	9	89.8	49.3
4/6/99	14.9	20	31.4	14.9	31.4	8	92.4	49.5
4/7/99	26.8	26.8	26.8	-	-	1	97.5	49.9
4/8/99	12.8	22.5	28.6	-	-	5	97.5	49.9
4/12/99	8.1	8.1	8.1	-	-	1	88.1	49.9
4/20/99	3.4	3.4	3.4	-	-	1	121.5	51

TABLE F-18. 1999 travel time of PIT tagged wild steelhead release from the Grande Ronde River to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/23/99	5.4	9.5	47.8	-	-	3	108.5	49.3
3/25/99	7.9	9	23.7	-	-	3	105.3	49.3
3/26/99	2.3	4.2	26.3	2.4	7.2	9	117	50
3/29/99	2.7	5.2	13.9	-	-	6	94.7	49
4/2/99	5.8	5.8	5.8	-	-	1	80.8	47.1
4/7/99	19.3	19.3	19.3	-	-	1	93.2	49.6
4/15/99	3.1	5	6.9	-	-	2	92.7	50.5
4/16/99	4.8	4.9	5.1	-	-	2	100.4	51.2
4/19/99	1.8	2.4	35.3	2.2	2.8	33	114.4	52
4/20/99	2.2	3.2	14.1	2.8	3.5	71	121.5	51
4/21/99	1.5	2.9	14.1	2.3	4.7	44	117.8	50.8
4/22/99	1.7	3.8	10.5	3	4.9	24	113.9	50.5
4/23/99	1.8	2.9	5.9	2	4.9	11	111.8	50.7
4/26/99	1.9	2.3	7.9	2	2.9	15	119.6	51
4/27/99	1.7	2.3	5.2	1.9	3.2	15	118	51
4/28/99	1.8	2.5	5.1	2.5	3.2	18	107.4	50.5
4/29/99	2.2	2.5	4.6	2.2	4.6	8	102.5	50.5
4/30/99	2.5	2.6	3.7	-	-	5	101.2	50.5
5/3/99	1.9	2.4	5.7	-	-	5	104.5	51
5/4/99	1.9	3	4.3	1.9	4.3	8	100	51
5/5/99	2.5	2.8	3.3	-	-	6	96.6	51.2
5/6/99	2.2	2.8	5.2	2.2	5.2	7	94.8	51.5
5/7/99	3.4	3.4	3.4	-	-	1	94.2	51.8
5/10/99	2.8	3	7.4	-	-	5	89.4	51.2
5/11/99	5.1	5.1	5.1	-	-	1	85.5	51.5
5/12/99	5.3	6	6.8	-	-	2	84.2	51.9
5/13/99	2.3	2.7	4.1	-	-	4	84.3	51.8
5/14/99	2.3	5.8	13.7	-	-	3	84.8	52.6
5/17/99	2.5	3.6	6.4	-	-	3	87.4	53.2
5/18/99	2.9	3.1	7.2	-	-	3	88.6	53.5
5/19/99	2	2.5	6.1	2.2	4.2	12	96.4	53.8
5/20/99	1.8	2.7	9	2.4	3.4	22	103.2	54.2
5/21/99	1.7	2.4	8.2	2.2	2.5	56	107.9	54.3
5/24/99	1.2	1.7	6.5	1.4	1.9	29	155.8	55.7
5/25/99	1.2	1.5	5.2	1.5	1.8	31	174.5	55.3

TABLE F-19. 1999 travel time of PIT tagged hatchery steelhead from the Grande Ronde River to Lower Granite Dam.

	Travel Time			Confidence Limits			Lower Granite	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
3/25/99	6.5	6.5	6.5	-	-	1	109.6	50.4
3/29/99	3.1	3.1	3.1	-	-	1	98.2	54
4/5/99	3	4.7	27.4	3.6	13.7	9	76.4	47.7
4/6/99	3.1	17.2	30.9	-	-	6	89.5	49.3
4/7/99	3	4	29.5	-	-	4	74.9	48
4/8/99	4.8	7.3	11.8	-	-	3	76.9	48
4/9/99	4	4.5	9.4	-	-	6	76.8	48
4/12/99	3.5	7.5	22.4	-	-	5	88.1	49.9
4/13/99	3.3	8	30.9	-	-	6	93.8	50.4
4/14/99	3.1	17.4	39.5	3.1	39.5	7	104.8	50.6
4/15/99	3	3.3	5.9	-	-	3	84.9	49.8
4/16/99	2.5	4	7.1	2.5	7.1	7	95.3	51
4/19/99	1.6	2.5	39.9	2.3	3.4	45	116.4	51.5
4/20/99	1.6	2.8	36.4	2.6	3	150	121.5	51
4/21/99	1.6	2.5	19.8	2.3	5	25	117.8	50.8
4/22/99	1.9	1.9	1.9	-	-	1	115	50.3
4/24/99	6.7	6.7	6.7	-	-	1	110.2	50.7
4/26/99	1.5	2.3	25.5	2	3.4	50	119.6	51
4/27/99	1.4	2.6	26.4	2.4	3	176	113.6	50.8
4/28/99	1.7	2.5	27.5	2.1	4.4	29	107.4	50.5
5/3/99	1.7	2.5	5.3	1.9	3.9	13	102.9	51
5/4/99	1.8	3.1	26.1	2.7	4.6	25	100	51
5/5/99	2.2	2.9	16.5	2.6	7.4	15	96.6	51.2
5/6/99	2.2	2.7	4.3	2.3	2.8	12	94.8	51.5
5/7/99	1.7	2.6	5.5	1.7	5.5	8	94.2	51.8
5/10/99	2.5	3.4	14.8	2.7	13.6	11	89.4	51.2
5/11/99	2.1	2.8	9.7	-	-	4	87.1	51.2
5/12/99	2.5	2.8	3	-	-	2	85.8	51.5
5/13/99	2.4	2.7	3.1	-	-	3	84.3	51.8
5/14/99	2.2	2.8	6.8	-	-	5	83.4	52
5/17/99	1.9	3	8	-	-	6	85.6	53
5/18/99	2.1	2.6	7.2	2.3	3.8	15	88.6	53.5
5/19/99	1.7	2.3	6.2	2.1	2.8	18	90.7	53.7
5/20/99	1.6	2.6	8.8	2.5	3.3	44	103.2	54.2
5/21/99	1.8	2.7	18.1	2.4	3.1	63	113.8	54.5
5/24/99	1.3	1.6	9.6	1.5	1.7	124	155.8	55.7
5/25/99	1.2	1.6	22.9	1.5	1.7	75	174.5	55.3

TABLE F-20. 1999 travel time of PIT tagged yearling chinook released from Rock Island Dam to McNary Dam.

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/16/99	20.5	20.5	20.5	-	-	1	163.8	46.5
4/18/99	8.2	14.6	17.3	-	-	6	168.3	47.1
4/20/99	9	16.5	26.8	10.3	24.5	11	175	46.7
4/21/99	6.4	15.9	32.3	13.1	19.1	33	177.7	46.7
4/23/99	6.3	15.6	28.1	11.7	18.2	53	179.4	47.1
4/24/99	8.2	19.2	30.8	14	22.6	27	174.5	47.6
4/25/99	6	15.7	34.5	11.6	19.7	26	176.8	47.4
4/26/99	6.8	15.4	33.6	11	21.9	24	177.2	47.3
4/27/99	7.3	12.6	32.9	9.7	17.4	24	179.6	47.1
4/28/99	7.2	9.9	14.1	-	-	6	182.3	46.7
4/29/99	7.3	11.7	21.4	10.6	16.3	19	176.8	47.3
4/30/99	15.3	15.3	15.3	-	-	1	172.3	47.9
5/2/99	7.9	13.3	31.9	12.6	14.2	66	169.8	47.9
5/3/99	9.4	13	16.3	-	-	5	168.8	46.8
5/4/99	9.5	13.4	16.1	9.5	16.1	8	168.3	47
5/5/99	10	13.4	18.2	-	-	4	165.9	48.4
5/6/99	10.3	12	13.6	-	-	5	164.6	48.4
5/7/99	11.3	13.3	14	-	-	5	166.1	48.8
5/8/99	10.6	11.5	13.3	-	-	3	165.9	48.8
5/9/99	7.3	11.7	17.3	9.1	15.5	9	165.9	49
5/10/99	7	9.2	17.8	7	17.8	7	165	48.4
5/11/99	6.9	9.7	14.7	8	12	12	166.2	48.9
5/12/99	6.9	8.9	12.3	6.9	12.3	7	167.5	48.9
5/13/99	7.5	9.6	11.3	7.5	11.3	7	160.5	49.5
5/14/99	5.9	8.7	15.6	6.7	9.8	13	159.8	49.5
5/15/99	7.2	8.9	14.2	7.4	13.9	10	156.5	47.7
5/16/99	5.4	8.6	19.1	7.2	9.7	22	152.2	48.1
5/17/99	6.7	8.2	9.6	-	-	4	150.6	49.9
5/18/99	6	7.2	8.5	-	-	6	146.8	49.8
5/21/99	6.9	6.9	6.9	-	-	1	146.5	50.6
5/22/99	8.6	8.6	8.6	-	-	1	151.8	51.5
5/23/99	6.9	9	11	-	-	2	156.9	51.7
5/24/99	5.8	17.6	29.4	-	-	2	183.5	52.4
5/25/99	5.6	5.6	5.6	-	-	1	163.9	54
5/26/99	5.5	5.5	5.5	-	-	1	169.6	54
5/30/99	7.6	7.6	7.6	-	-	1	189	53.2

TABLE F-21. 1999 travel time of PIT tagged subyearling chinook released from Rock Island Dam to McNary Dam.

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
6/16/99	12.1	12.1	12.1	-	-	1	184	57.8
6/17/99	11.1	14.4	17.8	-	-	2	188.7	57.8
6/18/99	7.7	14.6	35.6	7.7	35.6	7	188.7	57.8
6/19/99	8.3	13.4	16.1	8.3	16.1	7	189.9	57.8
6/20/99	8.5	17.9	32.7	12.7	27.5	18	189.9	57.9
6/21/99	9	11.5	42.3	9	42.3	8	194.8	57.7
6/22/99	6.5	10.4	41.7	7.4	20.2	9	199.2	57.8
6/23/99	5.4	14.7	40.4	10.7	32.3	12	194.4	58
6/24/99	8.5	22.9	38.3	-	-	6	197.3	59
6/26/99	7.5	12	28.5	7.5	26	9	191.1	58.1
6/27/99	6.4	13.7	34.8	9.8	18.8	13	190.3	58.4
6/28/99	10.1	30.8	39.8	15.1	36.4	13	189.7	60.2
6/29/99	12.9	29.6	37	15.4	35.1	10	189.9	60.3
6/30/99	15.7	28.9	36.2	-	-	6	189.2	60.4
7/1/99	11	17.8	18.7	-	-	3	193.7	59.6
7/2/99	32.7	33	33	-	-	3	181.1	59.4
7/3/99	12.4	12.4	12.4	-	-	1	193.8	59.4
7/5/99	15.7	15.7	15.7	-	-	1	193.5	60.2
7/6/99	12.9	24	31	13.4	30.8	9	186.4	59.9
7/7/99	10.1	25.1	39.8	11.9	38.2	10	182.5	59
7/8/99	7.8	14.1	29.8	-	-	5	194.9	60.5
7/9/99	10.2	26.8	29.1	25.4	27.8	12	179.6	59.8
7/10/99	7.6	12.9	24.8	-	-	5	196	60.9
7/11/99	22.2	25.9	27.8	-	-	5	178.2	60
7/12/99	8	19.9	26.3	10.4	23	13	180.7	58.9
7/13/99	9.2	21.7	37.7	20	26	29	178.2	59.6
7/14/99	7.8	18.3	34.7	16	22.4	32	177.7	58.7
7/15/99	7.8	11.6	30.3	10.7	16	28	184.3	61.5
7/16/99	7.4	16	28.3	9.4	21.9	17	173.9	58.5
7/17/99	7.4	15	24.1	9.8	19.7	15	171	58.3
7/18/99	8.8	17.6	31.1	11.7	21	19	168.7	59.5
7/19/99	9.7	18.7	42.9	15.1	20	37	167.9	60
7/20/99	4.5	16.6	39.1	14.8	19.2	51	167.6	59.7
7/21/99	9.2	13.8	32.8	12.7	15.6	35	166.8	58.9
7/22/99	9	16.4	42.1	14.4	23	15	164.2	59.8
7/23/99	6.3	14.4	36	11.1	26.7	22	163.8	59.4
7/24/99	9.7	15.4	30	10.8	23.8	12	160.3	59.9
7/25/99	6.3	18.3	35.3	11.4	23.5	22	161.2	60.9
7/26/99	5.4	9.7	18.5	5.4	18.5	7	160.4	58.2
7/27/99	9.1	13.8	40.2	10.8	24.9	11	159.4	60.1
7/28/99	7.3	14.4	27.5	12.4	19	12	158.3	60.3
7/29/99	7.7	15.3	34.1	7.7	34.1	8	160.4	60.7
7/30/99	5.7	14.2	37	8.8	18.3	19	160.5	60.5
7/31/99	5.8	10.4	20	6.6	15.3	9	156.7	61.8

TABLE F-21. 1999 travel time of PIT tagged subyearling chinook released from Rock Island Dam to McNary Dam.

(con't)

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
8/1/99	7.1	15.4	27	9.8	21.9	13	164.5	64.9
8/2/99	5.8	12.9	26.8	7.7	19.9	11	166.7	64.9
8/3/99	7.7	13.7	25.6	11.2	23.7	13	169.9	64.9
8/4/99	6.4	14.3	31.2	9.8	24.8	15	169.9	65
8/5/99	9.3	11.9	23.4	10	20.8	10	168.4	65
8/6/99	7.1	11.6	20.6	7.1	20.6	8	169.2	65
8/7/99	8.1	13.1	24	8.9	21.2	12	170.3	65.1
8/8/99	8.7	11.3	26.8	8.8	23.9	11	171.8	65.1
8/9/99	6.2	10	47	6.4	21	9	174.9	65.1
8/10/99	5.3	8.7	16.3	6.9	14.2	13	174.8	65.1
8/11/99	6.1	13.8	26.5	7.8	23.8	13	166.8	65.5
8/12/99	5.8	10.8	23.4	6.8	19.1	11	168	65.4
8/13/99	8.1	13.3	21	9.9	18	12	165	65.6
8/14/99	8	19.3	56.4	12.4	28.4	13	157.7	65.8

TABLE F-22. 1999 travel time of PIT tagged steelhead released from Rock Island Dam to McNary Dam.

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/16/99	13.3	20.1	23	-	-	3	163.5	46.4
4/17/99	6.2	6.2	6.2	-	-	1	137.7	46.1
4/18/99	10.3	13.6	33.1	-	-	4	167	47
4/19/99	6.7	13.6	16.1	-	-	4	171.1	47.1
4/20/99	15.3	15.3	15.3	-	-	1	175.8	46.4
4/21/99	5.2	6.5	20.2	5.3	16.6	11	169.6	47
4/22/99	8.1	9.6	16	-	-	5	180.8	47.4
4/23/99	4.5	9.6	21	4.5	21	8	182.3	47.5
4/24/99	6	7.4	22.9	6	22.9	7	182.4	47.5
4/25/99	4.1	5.8	8.7	4.9	7.9	9	184	47.6
4/26/99	3.9	5.9	29	5.2	18.7	17	185.6	47.6
4/27/99	4.4	6.5	19.4	5.9	11.2	19	189.3	45.6
4/28/99	6	6.8	10.3	-	-	6	189.5	45.9
4/29/99	4.4	5.4	13.6	-	-	6	190.9	45.2
4/30/99	4.4	6.4	10.2	4.4	10.2	7	184.8	46
5/1/99	4.3	6.1	17.3	4.6	6.7	17	180.8	46.1
5/2/99	4.8	6.5	13.9	5.8	8.1	27	176.5	46.8
5/3/99	4.5	5.4	9.4	4.8	6.4	15	175.8	46
5/4/99	4.3	5.6	19.9	5.3	6.3	26	170.9	46.7
5/5/99	4.4	7.5	14	5.3	11.6	13	162.9	49.2
5/6/99	4.2	6.3	16.7	5.6	7.4	24	159.6	49.1
5/7/99	4.4	6.1	9.7	-	-	4	159.5	49.3
5/8/99	5.4	7.5	16.2	7.3	9	23	162.2	47.6
5/9/99	5.4	5.9	12.4	5.7	6.6	19	163	49.6
5/10/99	4.5	6.8	19.7	5.7	13.7	14	164.1	47.5
5/11/99	4.6	6.2	14.6	5.5	6.8	24	165.7	47.3
5/12/99	4.4	6.2	13.4	5.7	10.3	16	167	47.7
5/13/99	4.3	7.3	14.3	5.6	9.7	17	172	48.5
5/14/99	3.7	7	15.8	5.9	9.6	34	170.2	48.8
5/15/99	4.2	6.3	11.3	5.4	7.3	31	170.8	48.6
5/16/99	4.3	5.6	13.7	5.4	6.6	34	163	48.9
5/17/99	4.5	6.9	8.9	5.4	8.3	14	152.3	49.4
5/18/99	4.5	7	23.2	5.4	10.6	11	146.8	49.8
5/19/99	4.4	7.7	17.1	5.5	12.6	11	150.5	50.4
5/20/99	4.5	7.6	10.9	-	-	5	150.1	50.7
5/21/99	5.4	8.3	11.2	7.4	8.7	13	150.2	51
5/22/99	6.3	7.8	10.7	7.5	9.6	14	150.6	51.2
5/23/99	5.3	6.6	12.3	5.3	12.3	7	153.8	51.1
5/25/99	4.3	5.6	9.4	-	-	4	163.9	54
5/26/99	5.9	7.3	9.9	-	-	5	172.1	53.8
5/27/99	4.8	5.3	5.5	-	-	5	170.7	54
5/28/99	4.7	5.5	6.5	-	-	5	175	53.6
5/29/99	4.2	5.3	9.6	-	-	5	175.6	53.5

TABLE F-23. 1999 travel time of PIT tagged sockeye released from Rock Island Dam to McNary Dam.

	Travel Time			Confidence Limits			Priest Rapids Dam	
Release Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
4/16/99	6.1	6.1	6.1	-	-	1	126.2	45.9
4/17/99	12.2	12.2	12.2	-	-	1	157.3	46.7
4/18/99	6.7	6.9	16.1	-	-	3	150.7	46.5
4/20/99	4.7	14.9	24.9	4.7	24.9	7	175.8	46.4
4/21/99	7	12.2	28.8	7	28.8	7	177.4	47.3
4/22/99	7.3	10.6	22.4	9.6	16.9	18	181.3	47.4
4/23/99	5.4	8.3	11.5	5.4	11.5	8	181.9	47.4
4/24/99	4.8	7.7	10.6	-	-	2	182.3	47.6
4/25/99	5.5	9	25.8	-	-	4	185.3	46.1
4/26/99	5.2	5.4	5.7	-	-	2	186.3	47.5
4/27/99	7	9	19.3	-	-	6	186.4	46.3
4/28/99	4.8	8	24.2	7.2	8.9	72	187.1	46.2
4/29/99	4.4	8.2	35	6.9	9	67	185	46.4
4/30/99	4.1	7.2	34.3	6.2	8.5	30	182.9	46.4
5/1/99	4.4	6.3	24.1	5.7	7.7	33	180.8	46.1
5/2/99	4.6	6.2	18.2	5.1	7.3	17	176.6	46.3
5/3/99	4.6	6.2	11.4	5.9	7.2	25	175.9	46.6
5/4/99	6.1	7	11	-	-	6	168.7	47
5/5/99	5.2	7.2	24.6	5.7	16.8	12	162.4	49.1
5/6/99	4.7	6.5	10	5.2	8.2	15	160.5	49.2
5/7/99	4.7	6.1	15.6	5.1	8.3	13	159.5	49.3
5/8/99	5.1	6.8	10.7	5.8	8.3	16	161.7	49.5
5/9/99	4.6	5.8	23.2	4.6	23.2	8	163	49.6
5/10/99	4.9	5.2	14.7	5.2	6.2	20	160.8	49.5
5/11/99	3.8	5.6	16.2	5	6.6	30	165.7	47.3
5/12/99	4.1	5.6	10.9	4.3	7.7	13	167	47.7
5/13/99	5.1	6.2	10.9	5.1	7.9	9	171.1	48.1
5/14/99	4.2	4.9	9.9	4.2	9.9	8	171.8	47.8
5/15/99	4	5.2	14.6	4.3	6.2	15	173.8	48
5/16/99	4.2	5	10.2	4.3	8.6	11	169.2	48.3
5/17/99	4.6	5.2	9.2	4.6	9.2	8	162.3	51.7
5/18/99	3.3	4.3	10	4.1	7	11	158.7	51.8
5/19/99	4.1	5.8	7.9	4.2	7.6	10	144.7	49.4
5/20/99	4.7	5.9	11.2	4.7	11.2	7	143	49.7
5/21/99	4.4	5.4	7	-	-	6	137.1	49.5
5/22/99	3.9	4.6	7.4	4.2	5.3	18	141.4	49.8
5/23/99	4.1	4.2	4.3	-	-	2	144.6	49.4
5/24/99	4.2	5.7	7.3	-	-	6	159.9	50.9
5/25/99	4.3	4.3	4.3	-	-	1	165.8	54
5/26/99	4.8	6.8	12.1	-	-	5	172.1	53.8
5/27/99	4	7.8	10.3	-	-	4	179.1	53.6
5/28/99	6.2	11.6	17.1	-	-	2	190.2	53.3
5/29/99	7.9	7.9	7.9	-	-	1	185.9	53.3

TABLE F-24. 1999 travel time of PIT tagged yearling chinook released in the Snake River basin in the reach between Lower Granite Dam and McNary Dam (grouped by observation date at Lower Granite Dam).

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam		
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
04/11	8.9	18.2	23.2	12.4	23	10	105.1	48.3
04/12	10.7	11.7	21.2	10.7	21.2	7	102	47.8
04/13	10.1	14	23.7	-	-	6	107	48.2
04/14	10.9	13.2	24.3	10.9	24.3	8	108.7	48.3
04/15	12	14.8	19.1	13	19	10	111.2	48.9
04/16	9.6	15.6	28.9	13.9	18	12	111.8	49.2
04/17	9	14.2	22.5	10.9	18.5	13	113.7	49.3
04/18	11.6	17.8	19.6	11.6	19.6	7	113.5	49.8
04/19	8.7	13.2	25.5	9.3	19.4	14	116.6	49.6
04/20	6	12.4	27.1	11.1	19.9	12	117.5	49.7
04/21	8.7	12	25	9.2	16.1	16	116	49.9
04/22	7.7	11.7	24.6	10	13.1	39	114.9	50.2
04/23	6.1	9.9	15.3	9	11	34	113.7	50.2
04/24	8	10	19	9.2	10.7	32	113	50.5
04/25	8	11.2	36.3	9.7	12.3	44	111.6	50.7
04/26	7.6	11	28.2	10.5	11.5	93	110.2	50.9
04/27	6.3	11.1	27.8	10.3	11.4	113	108.9	51
04/28	7.3	10.2	19.3	9.5	10.9	92	107.2	51.1
04/29	6.9	10.6	29.5	9.8	11	88	103.6	50.9
04/30	6.9	10.4	30.9	9.7	11.3	80	103.1	50.9
05/01	7.6	10.6	24.5	10.2	11.3	78	101.2	50.8
05/02	6.7	10.6	25.4	10	11.2	93	100.1	50.8
05/03	5.8	10.1	17.1	9.6	10.7	123	99.4	50.7
05/04	7	10.6	20.2	10.1	10.9	149	96.9	50.9
05/05	6.4	9.8	25.5	9.3	10.5	136	95.2	50.8
05/06	6.6	10.3	20.1	9.8	11.2	123	93.7	50.9
05/07	6.3	10.6	20.9	10.3	11	141	91.3	51.1
05/08	7.2	11	19.5	10.7	11.3	134	91	51.1
05/09	6.8	10.1	23.1	9.4	10.6	77	90	51.2
05/10	6.3	10.1	17.1	9.2	11	92	90	51.4
05/11	6.6	10.2	25.7	9.7	10.9	93	89.8	51.5
05/12	6.4	10.1	27.9	9.3	10.6	85	92	51.8
05/13	6.7	10.7	17.1	10.4	11.2	77	97.5	52.2
05/14	6.2	10.9	19.1	10.3	11.5	92	103.3	52.5
05/15	6.3	10.6	19.7	9.6	11.2	103	110.6	52.8
05/16	5.6	10.1	23.6	9.2	10.7	69	112.8	52.8
05/17	6.8	10	21.5	9.2	11	56	122.7	53.1
05/18	7	9.9	26.7	9.5	10.3	81	129.7	53.5
05/19	7	10	17.8	9.1	10.1	68	136.5	53.9
05/20	5.8	9.7	24.6	9	10.2	89	144.2	54.4
05/21	5.7	9.3	21.7	8.8	10.6	69	149.2	54.6
05/22	5.6	9	13.2	8.2	9.7	43	157	55.1
05/23	5.3	8.6	17.5	8.3	9.5	68	162.3	55.5
05/24	5.9	8.6	22	8.1	9.2	73	168.6	55.9
05/25	4.8	8.1	28.9	7.4	8.4	83	172.6	56.2

TABLE F-24. 1999 travel time of PIT tagged yearling chinook released in the Snake River basin in the reach between Lower Granite Dam and McNary Dam (grouped by observation date at Lower Granite Dam).

(con't)

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam		
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
05/26	4.2	7.8	13.8	7.3	8.4	65	173.9	56.4
05/27	4.8	7.3	30.4	6.2	8.1	25	173.3	56.6
05/28	3.2	6.4	15.2	6.1	7.1	40	170.1	56.9
05/29	3.6	5.4	11.8	4.7	5.9	38	171.4	57
05/30	4.5	5.3	15.2	5	5.9	39	170.8	57
05/31	5.3	6.4	14.2	6.1	8	21	164.7	57.3
06/01	5.9	6.6	11.1	6.1	7.5	17	157.6	57.5
06/02	6.3	7.4	10.5	6.7	7.8	15	152.6	57.6
06/03	7.3	8.2	9.9	7.3	9.9	8	142.3	57.3
06/04	6.6	8	18.7	7	9.4	10	136.3	57

TABLE F-25. 1999 travel time of PIT tagged steelhead released in the Snake River basin in the reach between Lower Granite Dam and McNary Dam (grouped by observation date at Lower Granite Dam).

Lower Granite	Travel Time			Confidence Limits		Ice Harbor Dam		
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
04/24	5.2	12.8	29.5	8.9	16.3	16	110.4	50.6
04/25	5.3	9.1	31.1	7.7	12.4	19	113	50.6
04/26	5.4	10	15.9	8.9	11.8	15	111.7	50.8
04/27	5.3	9.8	19.1	5.6	13.5	13	109.6	51.1
04/28	8.2	16.2	31.9	8.2	31.9	7	102.1	50.9
04/29	5.9	7.2	8.5	-	-	6	106.7	51.1
04/30	5.5	8.6	12.2	5.5	12.2	8	103.5	51
05/01	6.2	7.8	15.8	6.6	9.2	18	103.4	51
05/02	4.9	8.6	10.4	7.6	9.8	19	102.4	50.8
05/03	5.9	8.7	24.6	7.1	10.8	28	100.5	50.7
05/04	5.6	8.6	27.7	7.2	9.5	30	98.6	50.7
05/05	6.7	10.7	24.8	7.7	19.9	16	94.5	50.9
05/06	5.5	11.1	35.7	7.4	15.3	19	93	51
05/07	5.2	10.1	32.4	7.8	13.6	27	91.9	51
05/08	5.4	12.4	22.1	8.3	15.4	22	91.2	51.2
05/09	6.9	10.3	28.3	9.5	12.5	26	90	51.2
05/10	6.8	9.7	22.2	7.6	13.8	24	90	51.4
05/11	7.3	9.2	13.6	7.3	13.6	7	89	51.5
05/12	6.8	13.6	32.1	6.8	32.1	8	106.4	52.4
05/13	6.6	11.3	19.1	6.6	19.1	7	97.5	52.2
05/14	8.7	12.8	19.4	9.4	15.9	15	115.3	52.9
05/15	8.7	9.9	17.5	8.9	14.9	10	104.5	52.5
05/16	6.7	11	23.2	6.7	23.2	8	119.8	53
05/17	7.3	10.7	26.5	7.3	26.5	8	126	53.3
05/18	6.7	9	30.5	7.1	23.4	9	126.4	53.2
05/19	6.9	10	21.9	8.1	14.8	11	136.5	53.9
05/20	6.5	9.8	36	8	15.3	16	144.2	54.4
05/21	6.5	10.4	11.3	6.5	11.3	8	151.6	54.8
05/22	5.7	7.2	37.5	6.2	8	15	152.5	54.6
05/23	4.8	7	12.2	5.9	8.7	17	159.6	55.1
05/24	4.3	7.4	18.1	5.9	10.1	26	167	55.6
05/25	4.5	7.4	34.1	6.5	8.2	52	171.9	56.1
05/26	4.2	6.8	22	6.2	9.1	45	174.5	56.4
05/27	4.1	5.8	37	5	7.5	34	174	56.6
05/28	3.4	5.3	14.4	4.9	6.6	41	170.3	56.8
05/29	3.7	5.9	20.2	4.7	6.6	35	169.2	57
05/30	3.7	6	25.7	4.8	6.9	39	168.3	57.1
05/31	5.4	6.1	12.6	5.4	8.6	11	164.7	57.3
06/01	4	5.9	14.6	5.4	6.9	19	159.7	57.4

TABLE F-26. 1999 travel time of PIT tagged yearling chinook release in any basin above McNary Dam in the reach between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
04/22	4.9	7.1	7.9	4.9	7.9	8	309.1	42.7
04/23	5.2	6.3	8.6	5.8	7.3	21	311.7	41.4
04/24	5.2	6.3	7.5	5.3	7.1	10	310	41.4
04/25	4.7	6.3	8.7	5.2	8.2	10	310.3	42.7
04/26	4.5	6.2	10.6	4.9	7.9	14	310	44
04/27	5.1	5.8	8.5	5.4	6.7	12	311.6	43.6
04/28	4.6	6.3	9.9	5.8	6.7	30	313.9	43.4
04/29	4.7	5.6	8.7	5.1	6.9	13	311	43.6
04/30	3.5	6.1	9.3	5.2	7	20	305.3	50.3
05/01	3.9	5.7	9.7	5.1	6.3	44	300.3	50.6
05/02	4.3	5.9	9.8	5.6	6.3	41	294.4	51
05/03	4.3	5.9	10.8	5.5	6.3	51	286.6	51
05/04	4.3	6.2	12.1	5.8	6.6	55	288.5	51.4
05/05	3.6	5.9	10.4	5.6	6.1	89	280.9	51.6
05/06	4.3	5.9	14.7	5.6	6.3	83	270	51.6
05/07	3.7	5.5	11.6	5.2	5.9	105	262.3	51.4
05/08	4.5	5.7	10.6	5.5	5.8	108	261.1	51.3
05/09	4.6	6	11.2	5.8	6	162	258.7	51.1
05/10	4	6.3	11.7	6.2	6.3	213	258.9	51
05/11	4	6.2	12	6	6.4	208	251.3	51
05/12	4.5	6.1	14.9	5.9	6.4	218	252	51
05/13	4.9	6.4	17.1	6.2	6.8	157	256.3	51.1
05/14	4.3	6.2	15.9	6	6.6	189	262.1	51.4
05/15	4.1	5.9	11.8	5.7	6.2	226	263.1	51.7
05/16	4.1	6	18.5	5.8	6.2	172	265.2	52.1
05/17	4.1	5.8	14.4	5.6	6	212	265.6	52.6
05/18	4.2	5.8	20.3	5.5	5.9	224	263.4	53
05/19	4.2	5.8	19	5.7	5.9	276	267.3	53.7
05/20	3.4	5.6	14.8	5.5	5.7	392	277	54
05/21	3.8	5.5	18.6	5.4	5.6	380	289.7	54.2
05/22	3.7	5.1	16.6	4.9	5.3	191	291.7	54.5
05/23	3.7	5	14.8	4.9	5.1	187	311.1	55
05/24	4	5	29	4.8	5.2	150	328.7	55.2
05/25	3.7	5	22.1	4.9	5.1	238	348.8	55.7
05/26	3.1	4.9	22.8	4.8	5.1	247	355.8	55.5
05/27	3	4.3	23.1	4.2	4.5	223	359.8	55.5
05/28	2.8	3.9	21.9	3.8	4.1	183	356.5	56.7
05/29	2.8	4	22.7	3.8	4	280	352.4	57
05/30	2.8	4.1	23.4	3.9	4.2	157	353	58
05/31	3	4.1	9.7	3.8	4.4	82	355.9	58
06/01	2.9	3.7	7.5	3.6	3.9	75	362.3	58
06/02	3.1	3.8	18.9	3.7	3.9	79	367.8	57.6
06/03	3.2	3.8	6.7	3.8	4	58	365.2	57.6
06/04	3.1	4	10.3	3.7	4.6	18	359.8	57.2
06/05	3.7	4.2	8	3.8	5.1	10	357.1	56.8
06/06	3.4	4.5	10.6	3.6	7.5	11	344.2	56.7
06/07	3.5	4.1	5.4	3.5	5.4	7	338.3	56.6

TABLE F-27. 1999 travel time of PIT tagged steelhead released in any basin above McNary Dam in the reach between McNary Dam and Bonneville Dam (grouped by observation date at McNary Dam).

McNary Dam	Travel Time			Confidence Limits			The Dalles Dam	
Passage Date	Min	Med	Max	Lower	Upper	Number	Flow	Temp
05/04	3.9	5.2	7.8	3.9	7.8	8	284.6	51.5
05/05	4	4.5	6.5	-	-	6	284.4	51.7
05/06	4.4	5.4	8.4	4.4	8.4	8	275.4	51.7
05/07	3.8	4.9	10.4	4.2	6.8	9	267.2	51.5
05/08	3.9	5.3	12.7	4	7.4	12	259.4	51.3
05/09	3.9	5.4	6.7	3.9	6.7	7	261.1	51.2
05/10	4.2	5	20	4.5	6	12	259.7	51
05/11	4.2	5.2	8	4.6	5.9	19	250	51
05/12	4	5.2	8.5	4.7	6.2	19	249.9	51
05/13	4	5.1	9.4	4.7	6.4	9	254.4	51
05/14	4.2	4.9	8.2	4.3	6	11	260.2	51.2
05/15	4	5.4	7.2	4.7	6.1	12	260.6	51.5
05/16	4.2	6.4	10	5.1	7.7	14	265.2	52.1
05/17	4.6	7	9.3	4.9	7.9	9	262.9	52.8
05/18	4.6	7.3	12.3	5.1	11.3	10	266.9	53.4
05/19	4.2	5.3	11.9	4.9	6.2	20	263.2	53.3
05/20	4.4	5.9	17.4	4.9	7.7	12	277	54
05/21	4.4	5.5	11.7	4.9	6.3	14	289.7	54.2
05/22	4	5.6	7.2	5.1	6.1	15	303.7	54.8
05/23	3.7	5.3	16.8	4	6	15	311.1	55
05/24	4.7	7.3	14.9	4.9	11.9	13	333.8	55.2
05/25	4	5.2	9.3	4.6	6	18	348.8	55.7
05/26	4	4.6	6.8	-	-	5	355.8	55.5
05/27	3.8	6	8.3	-	-	6	357.3	56.8
05/28	3.3	3.9	13	3.7	5	17	356.5	56.7
05/29	2.9	4	7.6	3.5	4.3	32	352.4	57
05/30	3	4.4	8.3	3.9	4.6	40	353	58
05/31	3.3	5	7	3.7	5.8	16	357.5	58
06/01	3.7	4.4	6.9	4	5	22	362.3	58
06/02	3.6	5.6	9.3	4.5	7.5	24	359.9	57.3
06/03	3.1	4.6	8.9	4.4	5	25	360.7	57.3
06/04	3.6	5.1	9.5	4.4	7.3	17	360.8	57
06/05	3.6	5.1	7.5	3.6	7.5	8	354	56.7

APPENDIX G

Reach Survival Estimates for Fish Released from Traps, Hatcheries, and Rock Island Dam in 1999

<u>Description of Reach Survival Tables:</u>

Table G-1 presents 1999 survival estimates for yearling chinook and steelhead released from traps on the lower Salmon (103 km above mouth at Twin Bridges), lower Imnaha (6.8 km above mouth), lower Grande Ronde (5 km above mouth), and mainstem Snake (225 km above mouth at Lewiston) rivers through a series of three reservoirs and dams to the tailrace of Lower Monumental Dam. The Seber (1965) and Jolly (1965) methodology and computer program RELEASE (Burnham *et al.* 1987) were used to obtain point estimates of survival for the series of reaches, along with corresponding standard errors of the estimates and the correlation between estimates from adjacent reaches. The three reaches were: trap location to Lower Granite Dam tailrace (denoted **lgr**); Lower Granite Dam tailrace to Little Goose Dam tailrace (denoted **lgs**); and Little Goose Dam tailrace to Lower Monumental Dam tailrace (denoted **lmn**). The product of these three reach estimates produced the entire 3-dam reach survival estimate from the trap's location to Lower Monumental Dam tailrace (denoted **surv_reach**). The associated standard errors (denoted **se_lgr**, **se_lgs**, and **se_lmn** for the respective reach estimates) and covariances derived from the correlation estimates (denoted **corr_lgrlgs** and **corr_lgslmn**) went into computing the variance for the overall reach estimate (denoted **var_reach**) using Meyer's (1975) formulas for propagation of error (*i.e.*, variance of the product of three random variables whose error may be correlated). Normally distributed 95% confidence intervals were computed for the overall reach survival point estimates, and are denoted **ul_reach** for the upper limit and **ll_reach** for the lower limit. Plots of the reach survival estimates with associated 95% confidence intervals are presented in Figures H – 1 through H – 4 for releases from the Salmon, Snake, Imnaha, and Grande Ronde rivers, respectively.

Table G-2 presents 1999 survival estimates for yearling chinook and steelhead from selected hatcheries in the Snake River basin through a series of reservoirs and dams. The first table provides survival estimates and confidence intervals through the 3-dam reach as described in the preceding paragraph. The second table extends the entire reach estimate further downstream to encompass the Lower Monumental Dam tailrace to McNary Dam tailrace reach (denoted **mcn**), and McNary Dam tailrace to John Day Dam tailrace reach (denoted **jda**). The product of the five reach estimates produced the entire 5-reach survival estimate from trap's release location to the tailrace of John Day Dam (again denoted **surv_reach**). Along with the additional standard errors (**se_mcn**, and **se_jda**) and correlations (**corr_lmnmcn**, and **corr_mcnjda**), the variance for the entire 5-reach survival estimate was computed using Meyer's (1975) formulas.

Table G-3 presents 1999 survival estimates for yearling and subyearling chinook, steelhead, and sockeye from several release sites in the Mid-Columbia River basin through one reach consisting of multiple reservoirs and dams. Winthrop Hatchery yearling chinook passed 6 dams, Wells Hatchery subyearling chinook passed 5 dams, Leavenworth Hatchery yearling chinook passed 4 dams, Rock Island Dam releases passed 3 dams, and Priest Rapids Hatchery, Ringold Hatchery, and Hanford Reach wild subyearling chinook all passed one dam. The tables present survival estimates (denoted **mcn**) and confidence intervals from release site to tailrace of McNary Dam.

Sources:

Burnham, K.P., D.R. Anderson, G.C. White, C. Bronwnie, and K.H. Pollock, 1987, *Design and analysis methods for fish survival experiments based on release-recapture*, American Fisheries Society Monograph 5, 437 pp.

Jolly, G.M., 1965, Explicit estimates from capture-recapture data with both death and immigration – stochastic model, *Biometrika*, 52: 225-247.

Meyer, S.L., 1975, *Data analysis for scientists and engineers*, John Wiley and sons, N.Y., 513 pp.

Seber, G.A.F., 1965, A note on the multiple-recapture census, *Biometrika*, 52: 249-259.

TABLE G-1. 1999 Survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn) and within the entire reach (surv-reach).

Site	Snake River Trap				
spec/rear type	Hatchery Chinook				
dates	4/5-4/16	4/19-4/23	4/26-4/30	5/3-5/14	5/17-5/25
lgr	0.95783	0.93535	0.94770	0.94266	0.93963
se_lgr	0.02615	0.02452	0.02648	0.03022	0.04201
lgs	0.93855	0.96163	0.94585	0.99049	0.99687
se_lgs	0.03110	0.03066	0.03336	0.04191	0.06045
lmn	0.93901	1.02970	0.94557	0.94416	0.98179
se_lmn	0.03410	0.04755	0.04130	0.05693	0.08909
corr_lgrlgs	-0.80950	-0.70573	-0.72946	-0.73083	-0.72816
corr_lgslmn	-0.22384	-0.23383	-0.25592	-0.29927	-0.30588
N	1042	606	599	865	1078
ul_reach	0.90047	1.00670	0.91621	0.97531	1.06601
ll_reach	0.78783	0.84564	0.77898	0.78781	0.77325
surv_reach	0.84415	0.92617	0.84759	0.88156	0.91963
var_reach	0.00083	0.00169	0.00123	0.00229	0.00558

Site	Salmon River Trap					
species/reartype	Hatchery Chinook					
dates	3/18-3/25	3/29-4/2	4/5-4/9	4/12-4/16	4/19-4/23	4/26-4/30
lgr	0.73527	0.76118	0.79031	0.77650	0.85009	0.85073
se_lgr	0.02341	0.03533	0.03568	0.03364	0.03569	0.04646
lgs	0.94024	0.95111	0.92188	1.03320	1.01245	0.93868
se_lgs	0.03346	0.05125	0.05241	0.05572	0.05715	0.06234
lmn	0.94352	0.81589	0.99722	0.82627	0.79226	0.94472
se_lmn	0.04161	0.04793	0.07841	0.06070	0.05821	0.08417
corr_lgrlgs	-0.64528	-0.66966	-0.67281	-0.61044	-0.65543	-0.75733
corr_lgslmn	-0.28319	-0.34378	-0.27288	-0.37872	-0.39051	-0.26247
N	1185	604	614	569	694	690
ul_reach	0.70763	0.65390	0.83273	0.74838	0.76642	0.87573
ll_reach	0.59694	0.52744	0.62037	0.57741	0.59734	0.63309
surv_reach	0.65229	0.59067	0.72655	0.66290	0.68188	0.75441
var_reach	0.00080	0.00104	0.00293	0.00190	0.00186	0.00383

TABLE G-1. 1999 Survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn) and within the entire reach (surv-reach).

(continuation of G-1 above)

Site	Salmon River trap		Imnaha River trap		Grande Ronde R trap	
species/reartype	Hatchery Chinook		Hatchery Chinook		Hatchery Chinook	
dates	5/3-5/7	5/10-5/21	4/4-4/10	4/11-4/16	3/17-3/26	3/29-4/9
lgr	0.84952	0.88635	0.70797	0.70804	0.73740	0.73822
se_lgr	0.05319	0.05164	0.03452	0.03335	0.03567	0.02971
lgs	0.89452	0.97862	0.88625	0.92583	0.84108	0.94966
se_lgs	0.06975	0.07493	0.04730	0.04791	0.04531	0.03942
lmn	0.90499	0.92168	0.96373	0.93761	0.93547	1.00740
se_lmn	0.08697	0.08298	0.05982	0.06339	0.04605	0.05163
corr_lgrlgs	-0.75942	-0.73791	-0.68844	-0.67076	-0.78297	-0.71046
corr_lgslmn	-0.27575	-0.35845	-0.22056	-0.24018	-0.20375	-0.19674
N	586	707	707	667	995	771
ul_reach	0.80590	0.91917	0.67996	0.69558	0.63709	0.77895
ll_reach	0.56952	0.67974	0.52940	0.53366	0.52328	0.63354
surv_reach	0.68771	0.79946	0.60468	0.61462	0.58019	0.70625
var_reach	0.00364	0.00373	0.00148	0.00171	0.00084	0.00138

Site	Snake River Trap				
spec/rear type	Wild Chinook				
dates	3/22-4/2	4/5-4/16	4/19-4/23	4/26-4/30	5/17-5/25
lgr	0.94956	0.92600	0.96119	0.96313	0.96996
se_lgr	0.02919	0.02048	0.02144	0.02409	0.03982
lgs	0.97334	1.01739	0.97435	0.93779	0.93324
se_lgs	0.03623	0.02521	0.02672	0.02871	0.04808
lmn	0.93551	0.90204	0.89956	0.95835	0.97761
se_lmn	0.03123	0.02805	0.03220	0.03613	0.06093
corr_lgrlgs	-0.79275	-0.72978	-0.72028	-0.75020	-0.79708
corr_lgslmn	-0.32443	-0.29192	-0.25949	-0.20118	-0.24998
N	697	766	596	598	615
ul_reach	0.91330	0.89752	0.89822	0.92841	0.98377
ll_reach	0.81598	0.80210	0.78671	0.80279	0.78610
surv_reach	0.86464	0.84981	0.84246	0.86560	0.88494
var_reach	0.00062	0.00059	0.00081	0.00103	0.00254

TABLE G-1. 1999 Survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn) and within the entire reach (surv-reach).

(continuation from G-1 above)

Site	Salmon River trap				
species/reartype	Wild Chinook				
dates	3/18-3/25	3/29-4/2	4/12-4/16	4/19-4/23	4/26-4/30
lgr	0.88909	0.88495	0.88939	1.01536	0.93881
se_lgr	0.02383	0.02453	0.02303	0.03601	0.05426
lgs	0.98209	0.97626	0.98368	0.86302	0.92808
se_lgs	0.02944	0.02972	0.02804	0.03791	0.06441
lmn	0.90003	0.92756	0.94540	0.93427	0.93304
se_lmn	0.03188	0.03677	0.03717	0.03782	0.07738
corr_lgrlgs	-0.74247	-0.65466	-0.66184	-0.85067	-0.81207
corr_lgslmn	-0.25188	-0.25988	-0.23878	-0.17953	-0.21692
N	891	561	596	670	369
ul_reach	0.83797	0.86288	0.89024	0.88159	0.93661
ll_reach	0.73378	0.73983	0.76398	0.75577	0.68928
surv_reach	0.78587	0.80135	0.82711	0.81868	0.81294
var_reach	0.00071	0.00099	0.00104	0.00103	0.00398

Site	Imnaha River trap					Grande Ronde River trap
species/reartype	Wild Chinook					Wild Chinook
dates	3/28-4/3	4/4-4/10	4/11-4/16	4/17-4/24	5/3-5/14	4/12-4/30
lgr	0.87655	0.90578	0.91377	0.91075	0.90450	0.89848
se_lgr	0.02013	0.02556	0.02056	0.01814	0.04107	0.02617
lgs	0.97595	0.97431	0.97102	1.01494	0.96015	0.96623
se_lgs	0.02484	0.03209	0.02522	0.02465	0.05405	0.03218
lmn	0.90591	0.91289	0.90641	0.90302	0.93399	0.95012
se_lmn	0.02641	0.03703	0.02933	0.03265	0.07383	0.04158
corr_lgrlgs	-0.71644	-0.74032	-0.68996	-0.60959	-0.74156	-0.70324
corr_lgslmn	-0.24869	-0.24465	-0.25727	-0.34705	-0.26297	-0.23628
N	1114	744	801	861	521	607
ul_reach	0.81843	0.86671	0.85382	0.88884	0.92738	0.89378
ll_reach	0.73151	0.74454	0.75468	0.78059	0.69486	0.75587
surv_reach	0.77497	0.80562	0.80425	0.83471	0.81112	0.82483
var_reach	0.00049	0.00097	0.00064	0.00076	0.00352	0.00124

TABLE G-1. 1999 Survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn) and within the entire reach (surv-reach).

(continuation from G-1 above)

Site	**Salmon River Trap**				**Snake River Trap**	
species/rearingtype	**Hatchery Steelhead**				**Hatchery Steelhead**	
dates	4/14-4/29	4/30-5/6	5/7-5/12	5/13-5/21	4/19-4/23	4/26-4/30
lgr	0.87660	0.86344	0.77546	0.81527	0.94023	0.95059
se_lgr	0.02550	0.02921	0.03315	0.02685	0.01831	0.02006
lgs	0.96323	0.94408	0.96508	0.97608	0.97557	0.99988
se_lgs	0.03343	0.04518	0.05083	0.04175	0.02562	0.02880
lmn	0.87095	0.81886	0.83649	0.93024	0.94054	0.93098
se_lmn	0.04391	0.05883	0.06045	0.06101	0.04250	0.04983
corr_lgrlgs	-0.54522	-0.55719	-0.61608	-0.51419	-0.56548	-0.61092
corr_lgslmn	-0.31727	-0.36394	-0.34682	-0.37089	-0.29473	-0.29525
N	455	588	629	594	606	602
ul_reach	0.80574	0.75318	0.70748	0.82834	0.93512	0.97137
ll_reach	0.66506	0.58180	0.54454	0.65217	0.79033	0.79838
surv_reach	0.73540	0.66749	0.62601	0.74025	0.86272	0.88487
var_reach	0.00129	0.00191	0.00173	0.00202	0.00136	0.00195

Site	**Snake River Trap**		**Grande Ronde River Trap**		
species/rearing type	**Hatchery Steelhead**		**Hatchery Steelhead**		
dates	5/3-5/14	5/17-5/25	4/19-4/23	4/26-4/30	5/17-5/25
lgr	0.90691	0.91203	0.89321	0.89407	0.87733
se_lgr	0.02836	0.02607	0.02483	0.02280	0.02434
lgs	0.92212	0.95125	0.96513	1.00007	0.96835
se_lgs	0.03819	0.03693	0.03597	0.03847	0.03746
lmn	0.81560	0.86684	0.86068	0.79816	0.82843
se_lmn	0.04040	0.04006	0.04776	0.05249	0.03983
corr_lgrlgs	-0.70420	-0.67738	-0.57089	-0.47369	-0.62721
corr_lgslmn	-0.34645	-0.39574	-0.35636	-0.40750	-0.42011
N	1188	1311	619	607	1235
ul_reach	0.74036	0.80982	0.81588	0.79598	0.76015
ll_reach	0.62378	0.69426	0.66803	0.63134	0.64745
surv_reach	0.68207	0.75204	0.74196	0.71366	0.70380
var_reach	0.00088	0.00087	0.00142	0.00176	0.00083

TABLE G-1. 1999 Survival estimates for trap released fish to Lower Granite Dam tailrace (lgr), between subsequent dams (lgs and lmn) and within the entire reach (surv-reach).

(continuation from G-1 above)

Site	Imnaha River trap				
species/reartype	Hatchery Steelhead				
dates	4/11-4/16	4/17-4/24	5/10-5/14	5/17-5/20	6/7-6/24
lgr	0.87637	0.79722	0.85018	0.86108	0.89064
se_lgr	0.02969	0.02358	0.03524	0.01612	0.02120
lgs	0.93974	1.00331	0.93045	1.02122	0.81112
se_lgs	0.04548	0.03784	0.04872	0.02706	0.02646
lmn	0.84537	0.87532	0.87479	0.89901	0.93718
se_lmn	0.05474	0.05035	0.05152	0.03594	0.05267
corr_lgrlgs	-0.58417	-0.50603	-0.72734	-0.54645	-0.65621
corr_lgslmn	-0.40231	-0.39458	-0.35153	-0.41779	-0.18343
N	656	774	1131	1849	1382
ul_reach	0.77395	0.77229	0.76120	0.84474	0.75088
ll_reach	0.61846	0.62797	0.62280	0.73634	0.60317
surv_reach	0.69621	0.70013	0.69200	0.79054	0.67703
var_reach	0.00157	0.00136	0.00125	0.00076	0.00142

Site	Snake River Trap		Grande Ronde R Trap		Imnaha River Trap	
species/rearing type	Wild Steelhead		Wild Steelhead		Wild Steelhead	
dates	4/19-4/30	5/17-5/25	4/19-4/30	5/17-5/25	5/10-5/14	5/17-5/20
lgr	0.95162	0.85084	0.95582	0.94683	0.89702	0.92096
se_lgr	0.02943	0.03824	0.02161	0.03411	0.03668	0.02760
lgs	0.95113	1.05994	0.93932	0.94572	1.00111	1.00023
se_lgs	0.03620	0.06473	0.02802	0.04569	0.05223	0.04153
lmn	0.95102	0.85490	0.91810	0.87974	0.84535	0.87817
se_lmn	0.05789	0.07631	0.03996	0.06098	0.04708	0.04974
corr_lgrlgs	-0.68639	-0.58602	-0.67726	-0.69826	-0.74063	-0.61190
corr_lgslmn	-0.20125	-0.41863	-0.24595	-0.29468	-0.39128	-0.41247
N	319	412	664	525	1053	580
ul_reach	0.96147	0.88741	0.89174	0.88580	0.82669	0.88608
ll_reach	0.76008	0.65456	0.75684	0.68971	0.69158	0.73180
surv_reach	0.86078	0.77098	0.82429	0.78776	0.75913	0.80894
var_reach	0.00264	0.00353	0.00118	0.00250	0.00119	0.00155

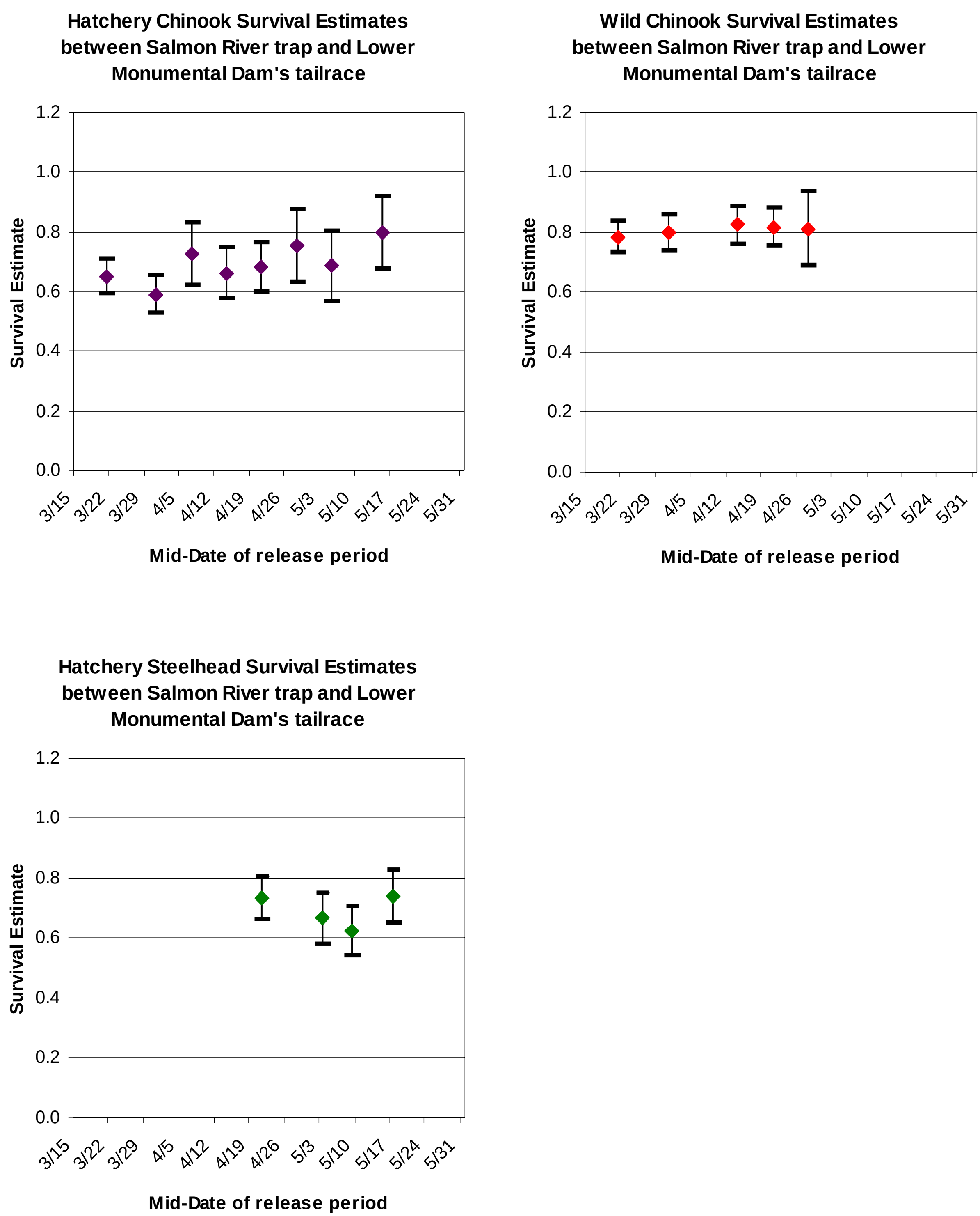

FIGURE G-1. Chinook and Steelhead Survival Estimates between Salmon River trap and Lower Monumental Dam's tailrace.

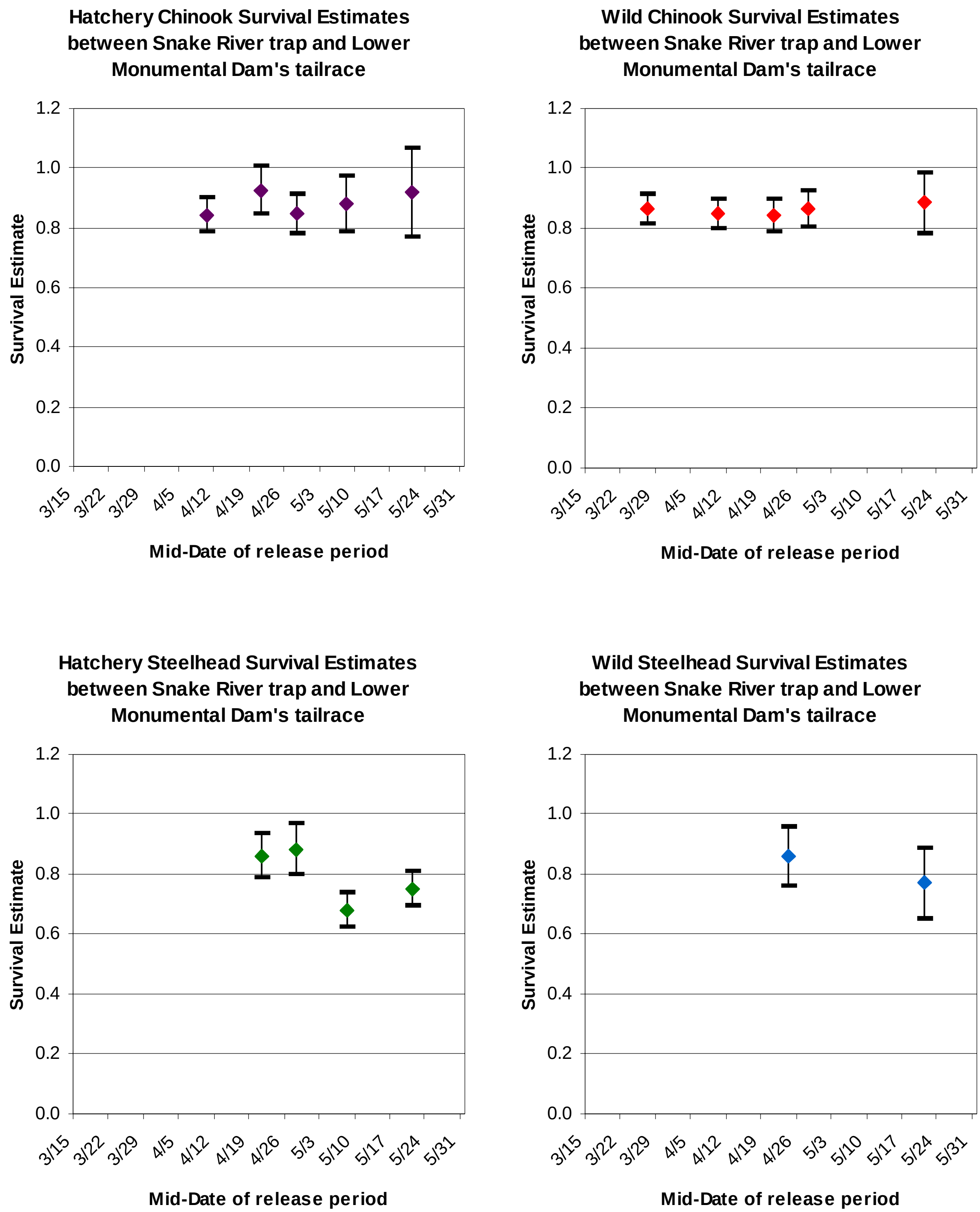

FIGURE G-2. Chinook and Steelhead Survival Estimates between Snake River trap and Lower Monumental Dam's tailrace.

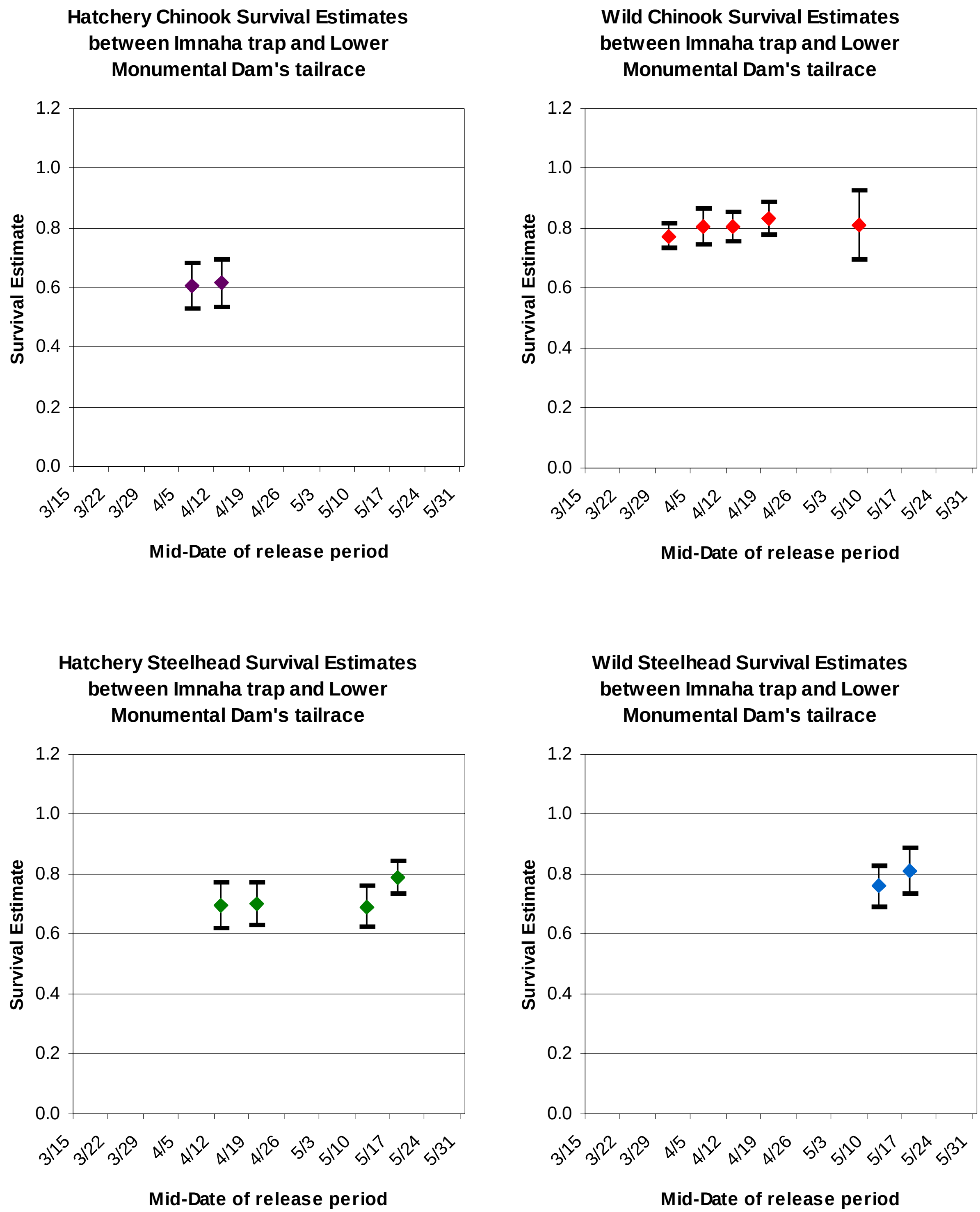

FIGURE G-3. Chinook and Steelhead Survival Estimates between Imnaha River trap and Lower Monumental Dam's tailrace.

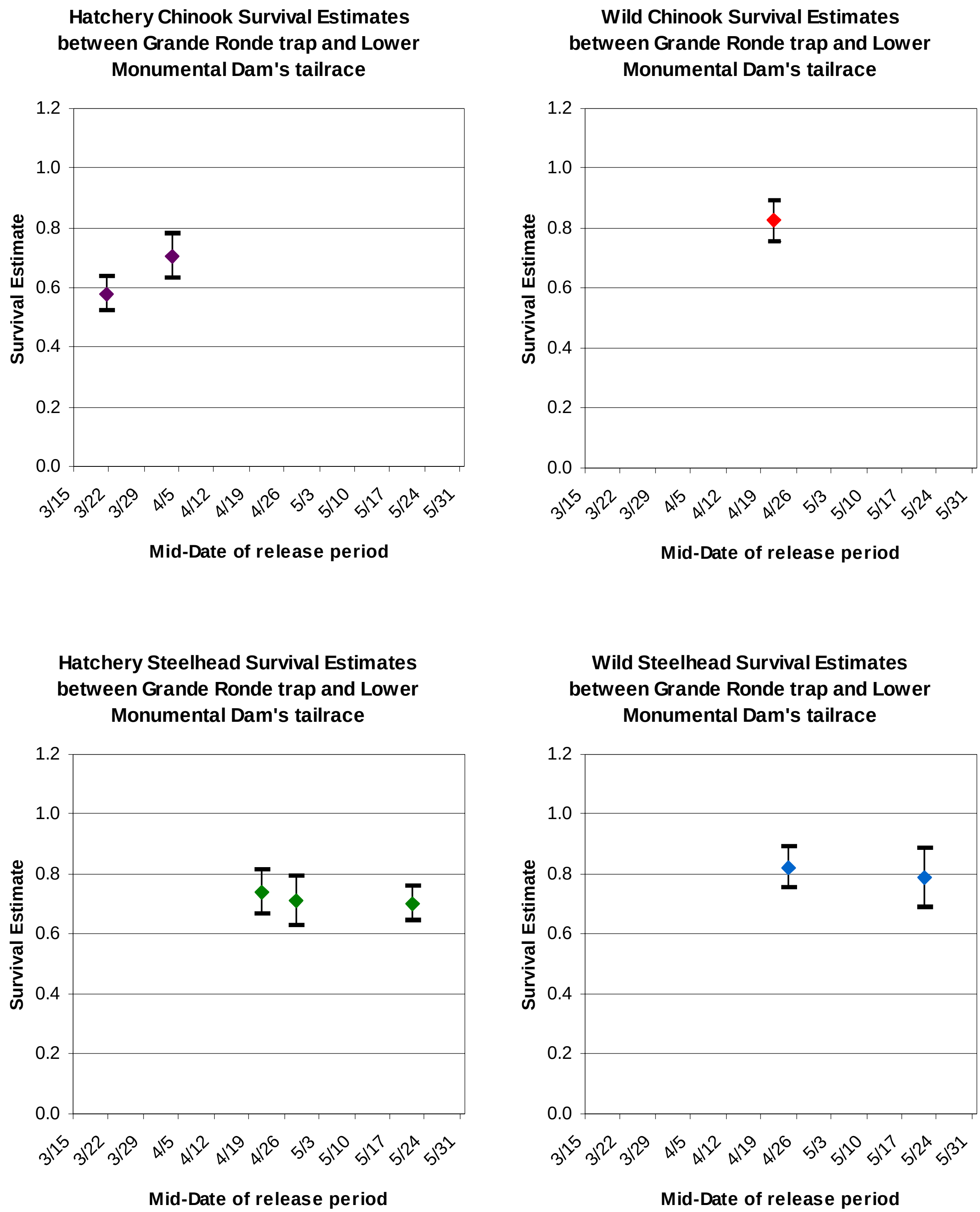

FIGURE G-4. Chinook and Steelhead Survival Estimates between Grande Ronde River trap and Lower Monumental Dam's tailrace.

TABLE G-2. 1999 Survival Estimates for Snake River Basin hatchery fish to Lower Granite Dam tailrace (lgr), between subsequent dams, and within the entire reach (surv-reach) for reaches extending to Lower Monumental Dam tailrace (first table) and to John Day Dam tailrace (second table).

Hatchery	McCall SFH	Rapid River SFH	Imnaha Acclimation Pond	Lookingglass SFH	Dworshak NFH	
species	**Chinook**	**Chinook**	**Chinook**	**Chinook**	**Chinook**	**Steelhead**
dates	4/6/99	V: 4/2/99	V: 3/16/99	V: 3/15/99	4/7-4/8/99	4/26-4/30
lgr	0.64924	0.74827	0.66968	0.65875	0.85314	0.75093
se_lgr	0.00839	0.00647	0.00947	0.00642	0.01137	0.01131
lgs	0.91675	0.92425	0.91669	0.93156	0.88460	0.99203
se_lgs	0.01506	0.01070	0.01597	0.01106	0.01403	0.01706
lmn	0.93775	0.95496	0.94955	0.95271	0.95385	0.86623
se_lmn	0.01368	0.01043	0.01604	0.00768	0.00886	0.02295
corr_lgrlgs	-0.87578	-0.86186	-0.84917	-0.88154	-0.94382	-0.54640
corr_lgslmn	-0.24052	-0.21045	-0.22029	-0.13985	-0.14950	-0.32787
N	47802	47802	22656	44548	47840	3715
ul_reach	0.57209	0.67354	0.60065	0.59424	0.73187	0.67735
ll_reach	0.54419	0.64734	0.56519	0.57504	0.70786	0.61324
avg_reach	0.55814	0.66044	0.58292	0.58464	0.71986	0.64529
var_reach	0.00005	0.00004	0.00008	0.00002	0.00004	0.00027

Hatchery	McCall SFH	Rapid River SFH	Imnaha Acclimation Pond	Lookingglass SFH	Dworshak NFH	
species	**Chinook**	**Chinook**	**Chinook**	**Chinook**	**Chinook**	**Steelhead**
dates	4/6/99	V: 4/2/99	V: 3/16/99	V: 3/15/99	4/7-4/8/99	4/26-4/30
lgr	0.64924	0.74827	0.66968	0.65875	0.85314	0.75093
se_lgr	0.00839	0.00647	0.00947	0.00642	0.01137	0.01131
lgs	0.91675	0.92425	0.91669	0.93156	0.88460	0.99203
se_lgs	0.01506	0.01070	0.01597	0.01106	0.01403	0.01706
lmn	0.93775	0.95496	0.94955	0.95271	0.95385	0.86623
se_lmn	0.01368	0.01043	0.01604	0.00768	0.00886	0.02295
mcn	0.90377	0.89990	0.88844	0.82605	0.86957	0.82535
se_mcn	0.02107	0.01722	0.02502	0.01306	0.01354	0.05262
jda	1.08709	0.96085	0.93437	0.86553	0.89453	0.90325
se_jda	0.05792	0.03967	0.05503	0.02943	0.02893	0.08613
corr_lgrlgs	-0.87578	-0.86186	-0.84917	-0.88154	-0.94382	-0.54640
corr_lgslmn	-0.24052	-021045	-0.22029	-0.13985	-0.14950	-0.32787
corr_lmnmcn	-0.40481	-0.41518	-0.42804	-0.40000	-0.42682	-0.30850
corr_mcnjda	-0.31887	-0.34205	-0.34234	-0.34685	-0.34163	-0.56170
N	47802	47802	22656	44548	47840	3715
ul_reach	0.60185	0.61381	0.53550	0.44393	0.59275	0.55365
ll_reach	0.49486	0.52831	0.43230	0.39208	0.52715	0.40847
avg_reach	0.54836	0.57106	0.48390	0.41800	0.55995	0.48106
var_reach	0.00074	0.00048	0.00069	0.00017	0.00028	0.00137

V: date denotes a volitional release spanning approx. one month. Date for Rapid River SFH is predicted date of median fish emigration. Dates for Imnaha AP and Lookingglass SFH are dates when volitional release was begun at facility.

TABLE G-3. 1999 Survival Estimates for Mid-Columbia River Basin fish to McNary Dam tailrace (Mcn).

Site	Leavenworth NFH	Winthrop NFH	Wells SFH	Priest Rapid SFH	Ringold SFH	Hanford Reach Columbia River
species /reartype	**Hatchery Chinook**	**Hatchery Chinook**	**Hatchery Chinook**	**Hatchery Chinook**	**Hatchery Chinook**	**Wild Chinook**
age group	**Yearling**	**Yearling**	**Subyrlg**	**Subyrlg**	**Subyrlg**	**Subyrlg**
dates	4/19	4/15	6/19	6/14-6/23	6/16	6/3-6/10
mcn	0.58611	0.56788	0.37287	0.75745	0.83467	0.39958
se_mcn	0.01855	0.02088	0.04703	0.04027	0.04826	0.02455
var_reach	0.00034	0.00044	0.00221	0.00162	0.00233	0.00060
N	7396	7486	5989	3805	2966	5038
ul_reach	0.62246	0.60881	0.46505	0.83638	0.92927	0.44769
ll_reach	0.54977	0.52695	0.28069	0.67852	0.74008	0.35147

Site	**Rock Island Dam**					
species/age	**Total Yearling Chinook**			**Total Steelhead**		
dates	4/20-4/30	5/2-5/15	5/16-5/31	4/20-5/5	5/6-5/13	5/14-5/22
mcn	0.71582	0.78089	0.75349	0.66225	0.64599	0.60806
se_mcn	0.04209	0.05863	0.09361	0.04760	0.05830	0.05343
var_reach	0.00177	0.00344	0.00876	0.00227	0.00340	0.00285
N	1295	1209	1290	1389	1281	1488
ul_reach	0.79831	0.89580	0.93697	0.75554	0.76025	0.71278
ll_reach	0.63333	0.66597	0.57001	0.56896	0.53172	0.50334

Site	**Rock Island Dam**				
species/age	**Total Sockeye**		**Total Subyearling Chinook**		
dates	4/20-5/3	5/4-5/22	6/17-6/30	7/1-7/15	7/16-7/31
mcn	0.64986	0.45641	0.60820	0.54476	0.49546
se_mcn	0.04548	0.03865	0.08081	0.08043	0.04827
var_reach	0.00207	0.00149	0.00653	0.00647	0.00233
N	1560	1615	1488	1302	1426
ul_reach	0.73901	0.53215	0.76659	0.70240	0.59006
ll_reach	0.56072	0.38066	0.44981	0.38711	0.40086

APPENDIX H

Estimated Proportion of Chinook and Steelhead Originating above Lower Granite Dam Transported

in 1999.

Proportion of Lower Granite Dam forebay population destined to be transported

Model to estimate proportion:

In the transportation proportion estimation procedure, the population of N smolts in Lower Granite Dam forebay is partitioned into X1 fish destined to be transported and X2 fish destined to migrate in-river. The proportion of fish in the transportation category is Pt =X1/N and the proportion of fish in the in-river category is (1-Pt)=X2/N. Below is the derivation of model for springtime migrants with three transportation dams – the procedure for summertime migrants is similar with the addition of a fourth transportation dam (McNary Dam).

The number of fish, x2, estimated to remain in-river below last transportation site for springtime migrants:

$$x2 = (((N*s1-t1)*s2-t2)*s3-t3) = N*s1*s2*s3 - t1*s2*s3 - t2*s3 - t3$$

where s1=survival from origin in Lower Granite Dam forebay to Lower Granite Dam tailrace
s2=survival from Lower Granite Dam tailrace to Little Goose Dam tailrace
s3=survival from Little Goose Dam tailrace to Lower Monumental Dam tailrace
t1=fish removed at Lower Granite Dam for transportation
t2=fish removed at Little Goose Dam for transportation
t3=fish removed at Lower Monumental Dam for transportation

To index x2 back to the starting population in Lower Granite Dam, X2, requires dividing by the survival estimate s1*s2*s3 from Lower Granite Dam forebay to Lower Monumental Dam tailrace.

$$X2 = x2/(s1*s2*s3) = N - t1/s1 - t2/(s1*s2) - t3/(s1*s2*s3)$$

The number of fish in the starting population destined to be transported then becomes

$$X1 = N-X2 = t1/s1 + t2/(s1*s2) + t3/(s1*s2*s3)$$

The proportion of fish in the starting population destined to be transported is

$$Pt = X1/N = t1/(N*s1) + t2/(N*(s1*s2)) + t3/(N*(s1*s2*s3))$$

The number of fish surviving to the tailrace of each dam is given by the following series of equations:

Lower Granite	$N1 = N*s1$
Little Goose	$N2 = (N1-t1)*s2 = N1*(1-t1/N1)*s2$
Lower Monumental	$N3 = (N2-t2)*s3 = N2*(1-t2/N2)*s3 = N1*(1-t1/N1)*s2*(1-t2/N2)*s3$

Substituting these equalities into the equation for Pt gives

$$Pt = t1/N1 + (1-t1/N1)*t2/N2 + (1-t1/N1)*(1-t2/N2)*t3/N3$$

Letting P1=t1/N1, P2=t2/N2, and P3=t3/N3 the equation for proportion of transport fish in Lower Granite Dam forebay destined for transportation becomes:

$$Pt = P1 +(1-P1)*P2 + (1-P1)*(1-P2)*P3$$

The P1, P2, and P3 proportions are computed using facility collection, transport, and population estimates for Lower Granite, Little Goose, and Lower Monumental dams, respectively. For sites J=1 to 3, the individual proportions P(J) are computed with

P(J) = transport number / population number
= (transport proportion * collection) / (collection / collection efficiency)
= transport proportion * collection efficiency

Model results:
The respective P(J) for yearling chinook and steelhead are shown in Tables 1 and 2 where transport proportion is based on data from the run-at-large at each dam and collection efficiency is estimated using Seber-Jolly mark-recapture models on PIT tagged fish released for the Smolt Monitoring Program in 1999. The respective P(J) for subyearling chinook are shown in Table 3 where transport proportion is based on data from the run-at-large and collection efficiency is estimated for McNary dam based on PIT tag data, but is estimated for the Snake River dams based on NMFS fish guidance efficiency estimates and 1999 spill proportions.

TABLE H-1. Yearling Chinook Model Input Data.

Site	Rear Type	Facility Collection	Estimated Population	Spill Proportion	Estimated Collection Efficiency	Transport Proportion	P(J)
LGR (J=1)	Wild	410,842	1,604,852	35.5%	0.256	0.94	0.241
	Hatchery	1,762,654	6,885,367	36.3%	0.256	0.94	0.241
LGS (J=2)	Wild	703,534	1,122,064	22.4%	0.627	0.99	0.621
	Hatchery	2,828,828	5,408,849	23.2%	0.523	0.99	0.518
LMN (J=3)	Wild	338,080	596,261	19.6%	0.567	0.92	0.522
	Hatchery	1,554,363	3,657,325	20.4%	0.425	0.92	0.391

TABLE H-2. Steelhead Model Input Data.

Site	Rear Type	Facility Collection	Estimated Population	Spill Proportion	Estimated Collection Efficiency	Transport Proportion	P(J)
LGR (J=1)	Wild	323,083	925,739	35.7%	0.349	0.92	0.321
	Hatchery	3,032,104	8,687,977	35.9%	0.349	0.92	0.321
LGS (J=2)	Wild	325,774	605,528	23.4%	0.538	0.95	0.511
	Hatchery	2,809,841	5,222,753	23.9%	0.538	0.95	0.511
LMN (J=3)	Wild	196,132	361,201	21.8%	0.543	0.87	0.472
	Hatchery	1,782,663	3,282,989	22.1%	0.543	0.87	0.472

TABLE H-3. Subyearling Chinook Model Input Data.

Site	Facility Collection	Estimated Population	Spill Proportion	FGE	Estimated Collection Efficiency	Transport Proportion	P(J)
LGR (J=1)	257,507	587,075	17.2%	0.53		1	0.439
LGS (J=2)	197,964	393,300	6.8%	0.54		1	0.503
LMN (J=3)	133,285	326,379	2.8%	0.42		1	0.408
MCN (J=4)	4,276,091	16,075,530	44.0%		0.266	0.8	0.213

TABLE H-4. Estimated Proportion Destined for Transportation in 1999.

Species- age group	Reartype	Transport Proportion
Yearling Chinook	Hatchery	0.777
	Wild	0.862
Steelhead	All	0.825
Subyearling Chinook	All	0.870

APPENDIX I

Hatchery Release Schedule

FISH PASSAGE CENTER DATA SYSTEM
HATCHERY RELEASES ABOVE BONNEVILLE DAM
1999 MIGRATION YEAR

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
COLV	Cassimer Bar	SO	1	UN	4/7/99	4/7/99	13,396	9	Okanogan R	Okanogan R	1997	100% RV clip; Trucked from hatchery to rel site at Okanogan RM 0.5
	Cassimer Bar Total						13,396					
Colville Total							**13,396**					
IDFG	**Clearwater**	CH	1	SP	7/15/98	8/5/98	304,600	67.7	Lochsa R	Clearwater R M F	1997	Rel in Whitesand Cr(Colt Killed Cr)ISS grp;ad clip;2.1k PIT
		CH	1	SP	7/20/98	7/20/98	12,889	30	Lochsa R	Clearwater R M F	1997	Rel in Pete King Cr; ISS group; 100% CWT; no ad clip.
		CH	1	SP	7/29/98	7/29/98	13,827	31	Lochsa R	Clearwater R M F	1997	Rel in Squaw Cr.; Iss group;100%CWT;no ad clip;_k PIT tagged
		CH	1	SP	9/24/98	9/24/98	162,119	18.4	Crooked R AcPd	S Fk Clearwater R	1997	100% RV clipped; .7k PIT tagged.
		CH	1	SP	9/29/98	9/29/98	5,712	37.5	Selway R	Clearwater R M F	1997	Wild Parentage?
		CH	1	SP	10/5/98	10/5/98	66,114	10.2	Red R AcPd	S Fk Clearwater R	1997	100% LV Clip; .7k PIT tagged.
		CH	1	SP	4/4/99	4/15/99	600,981	15.6	Crooked R AcPd	S Fk Clearwater R	1997	100% ad clip only.
		CH	1	SP	4/12/99	4/15/99	360,983	15.4	Red R AcPd	S Fk Clearwater R	1997	100% ad clip only.
		ST	1	SU	4/20/99	4/20/99	4,993	5.9	Red R	Clearwater R M F	1998	Supplemental plant; No fin clips; 100% PIT tagged.
		ST	1	SU	4/22/99	4/23/99	190,539	5.1	Clear Cr	Clearwater R M F	1998	100% ad clip; 40k adLV+CWT; Feed Experiment; .6k PIT tagged.
		ST	1	SU	4/27/99	4/29/99	400,465	5.3	S Fk Clearwater R	Clearwater R M F	1998	Rel at Red House Hole;100%adclip;60k adLV+CWT;.3k PIT tagged
	Clearwater Total						**2,123,222**					
	Eagle	SO	0	UN	7/30/98	7/30/98	7,246	52.2	Pettit Lake	Salmon R	1997	Reared at Eagle H; 100% ad clip.
		SO	1	UN	10/1/98	10/1/98	55,830	31.5	Redfish Lake	Salmon R	1997	Reared in net pen at Red Fish Lake from 7/7 to Oct. release; 100% ad
	Eagle Total						**63,076**					
	Magic Valley	ST	1	SU	3/27/99	6/3/99	74,724	4.1	Squaw Cr AcPd	Salmon R	1998	100% ad clip; .9k PIT tagged; Volitional Rel.
		ST	1	SU	4/3/99	5/12/99	315,335	4.1	Squaw Cr AcPd	Salmon R	1998	100% ad clip; 60k ad+CWT; .3k PIT tagged; rel near Acc. Pd.
		ST	1	SU	4/12/99	4/16/99	354,815	4.7	Little Salmon R	Salmon R	1998	100% ad clip; 20k adLV+CWT; .3k PIT tagged; Rel at Stinky Springs.
		ST	1	SU	4/16/99	4/26/99	329,630	3.7	Lemhi R	Salmon R	1998	150 k rel at Red Rock sec16;
		ST	1	SU	4/19/99	4/20/99	132,420	3.6	Shoup Br (Salmon F	Salmon R	1998	100% ad clip; 60k ad+CWT; .3k PIT tagged.
		ST	1	SU	4/21/99	4/28/99	305,392	4.1	McNabb/Salmon R	Salmon R	1998	Cottonwood & Tunnel Rock rel in Sec.18; 100% ad clip
		ST	1	SU	4/23/99	4/23/99	39,660	4.4	Sawtooth H	Salmon R	1998	100% ad clip; .3k PIT Tag.
		ST	1	SU	4/28/99	5/3/99	109,145	4.3	Salmon R	Salmon R	1998	Rel in Sec.18 at Tunnel Rock; 100% ad clip; 60k ad+CWT; .3k PIT
		ST	1	SU	4/29/99	5/5/99	268,925	4.2	E Fk Salmon R	Salmon R	1998	100% ad clip; 60k adLV+CWT.
		ST	1	SU	5/6/99	5/6/99	12,800	4	Little Salmon R	Salmon R	1998	100% ad clip.
	Magic Valley Total						**1,942,846**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	McCall	CH	1	SU	10/5/98	10/16/98	49,782	40	S Fk Salmon R	Salmon R	1997	100% CWT; no ad clip; 2k PIT tagged; Fish in AcPd at Stolle Meadows from 8/3/98 thru rel dates in October.
		CH	1	SU	4/4/99	4/8/99	1,182,611	23.9	S Fk Salmon R	Salmon R	1997	Rel at Knox Br; 739k ad clip only; 279k ad+CWT; 48k PIT tagged; 122.9k LV clip only (part of ISS group [ESU fish]).
	McCall Total						**1,232,393**					
	Niagara Spgs	ST	1	SU	3/22/99	4/4/99	657,665	4.4	Hells Canyon Dam	Snake R	1998	100% ad clip; 60k ad+CWT; .3k PIT tagged.
		ST	1	SU	4/5/99	4/5/99	30,369	4.8	Pine Bar/Salmon R	Salmon R	1998	100% ad clip.
		ST	1	SU	4/6/99	4/8/99	154,047	5.5	Hammer Cr	Salmon R	1998	100% ad clip; 60k ad+CWT; .3k PIT tagged.
		ST	1	SU	4/10/99	4/27/99	829,199	4.6	Pahsimeroi H	Pahsimeroi R	1998	100% ad clip; 60k ad+CWT; .3k PIT tagged.
		ST	1	SU	4/28/99	5/1/99	171,920	3.9	Little Salmon R	Salmon R	1998	100% ad clip; 30k ad+CWT; .3k PIT tagged.
	Niagara Springs Total						**1,843,200**					
	Pahsimeroi	CH	1	SU	4/14/99	4/19/99	135,669	9.9	Pahsimeroi H	Pahsimeroi R	1997	100% ad clip only; .5k PIT tag.
	Pahsimeroi Total						**135,669**					
	Powell	CH	1	SP	9/23/98	9/23/98	154,555	13.1	Powell AcPd	Lochsa R	1997	100% ad clip only.
		CH	1	SP	9/23/98	9/23/98	176,000	13.1	Powell AcPd	Lochsa R	1997	Acclim at Red R pd; rel at Powell; 100% ad clip; 100k ad+CWT; .7k PIT tagged.
		CH	1	SP	4/12/99	4/14/99	334,482	12.4	Powell AcPd	Lochsa R	1997	100% ad+CWT; size at rel study
	Powell Total						**665,037**					
	Rapid R	CH	1	SP	3/17/99	3/17/99	200,000	21.8	Little Salmon R	Salmon R	1997	Rel in L Salmon R above Rapid R; 100% ad clip only.
		CH	1	SP	3/18/99	4/19/99	2,847,283	17.9	Rapid R H	Little Salmon R	1997	2.7 mil ad clip only; 300k ad+CWT for US/Canada; 48k PIT tagged.
		CH	1	SP	3/18/99	3/19/99	300,000	21.8	Hells Canyon Dam	Snake R	1997	100% ad clip; Trucked to rel site below Hells Canyon Dam.
	Rapid R Total						**3,347,283**					
	Sawtooth	SO	1	UN	10/14/98	10/14/98	39,418	48	Redfish Lake	Salmon R	1997	100% ad clip;
		SO	1	UN	10/14/98	10/14/98	39,377	49	Alturas Lake	Salmon R	1997	100% ad clip;
		CH	1	SP	4/16/99	4/16/99	223,240	22.4	Sawtooth H	Salmon R	1997	107k CWT no ad clip;3k PIT tagged; 118k ad+CWT.
		ST	1	SU	4/23/99	4/23/99	457,084	5.1	Sawtooth H	Salmon R	1998	Transf from Hagerman; Acclimated; 100% ad clip; 120k ad+CWT 10-52-57..61, 63;Feed Diet study; 1.8k PIT
		SO	1	UN	5/5/99	5/5/99	10,028	17.9	Redfish Lake Cr	Salmon R	1997	750 PIT tag; 100% ad clip; 5k rel below Sawtooth Weir; remainder rel at Redfish L Creek.
	Sawtooth Total						**769,147**					
IDFG Total							**14,245,095**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
NEZP	Clearwater	CH	1	SP	7/7/98	7/8/98	83,748	48	Lochsa R	Clearwater R M F	1997	Rel in Boulder Cr; ad clip only.
		CH	1	SP	7/8/98	7/8/98	19,847	29	Lochsa R	Clearwater R M F	1997	Rel in Warms Springs R; 100% CWT no ad clip.
		CH	1	SP	3/19/99	3/19/99	74,638	19	Newsome Cr	S Fk Clearwater R	1997	100% CWT 10-51-32,10-53-04;no ad clip;1k PIT tag
		CH	1	SP	3/22/99	3/29/99	285,573	18	Selway R	Clearwater R M F	1997	Rel in Meadow Cr; 100% ad clip only; 1k PIT tag.
		CH	1	SP	3/31/99	4/2/99	147,975	20	Lolo Cr	Clearwater R M F	1997	100% CWT 10-51-12/31/34&10-53-03;noadclip/1kPIT
		CH	1	SP	4/19/99	4/19/99	39,640	11	S Fk Clearwater R	Clearwater R M F	1997	Rel in Mill Cr; 100% CWT 10-51-16; no ad clip.
	Clearwater Total						**651,421**					
	Kooskia	CO	1	UN	5/10/99	5/11/99	220,000	18	Clear Cr	Clearwater R M F	1997	50k CWT only; .8k PIT tag.
	Kooskia Total						**220,000**					
	Lookingglass	CH	1	SP	4/1/99	4/15/99	12,061	25	Lostine R	Grande Ronde R	1997	100% ad+CWT; Wild parentage; initial rel from Lostine Pd; 2 wk volitional rel.
	Lookingglass Total						**12,061**					
	Lyons Ferry	CH	1	FA	4/12/99	4/15/99	142,885	10	Pittsburg Landing	Snake R	1997	100% ad+CWT 63-04-51+Elastomer tagged [right green].
		CH	1	FA	4/12/99	4/15/99	153,719	10.4	Big Canyon (Clearw	Clearwater R M F	1997	100% ad+CWT 63-04-54+Elastomer tagged [Left Green].
		CH	1	FA	4/12/99	4/15/99	157,010	10	Cpt John AcPd	Snake R	1997	100% ad+CWT 63-09-53+Elastomer tagged [Left Blue].
		Ch	1	FA	4/26/99	4/28/99	74,732	10	Big Canyon (Clearw	Clearwater R M F	1997	100% ad+CWT 63-09-38+Elastomer Tag (left green); surplus fish.
		CH	0	FA	6/3/99	6/3/99	347,105	83	Big Canyon (Clearw	Clearwater R M F	1998	Acclim from 5/12 to rel; 200k CWT 63-10-25 w/no clips; 2k PIT tag.
		CH	0	FA	6/5/99	6/5/99	322,928	50	Cpt John AcPd	Snake R	1998	Acclim from 5/3 to rel; nonclipped; 2k PIT tag.
	Lyons Ferry Total						**1,198,379**					
	McCall	CH	1	SU	7/30/98	7/30/98	10,434	120	S Fk Salmon R	Salmon R	1997	Planted as parr in Dollar Cr; 100% CWT; no ad clip.
	McCall	CH	1	SU	8/5/98	8/5/98	38,161	147	S Fk Salmon R	Salmon R	1997	Planted in Buckhorn Cr; 100% CWT; no ad clip.
	McCall	CH	1	SU	10/7/98	10/8/98	158,240	53.9	S Fk Salmon R	Salmon R	1997	Sup. rel scatter planted in S Fk Salmon R; 100% CWT; no ad clip.
	McCall	CH	1	SU	4/5/99	4/8/99	39,000	18	S Fk Salmon R	Salmon R	1997	100% CWT; no ad clip.
	McCall Total						**245,835**					
	Powell	CH	1	SP	4/5/99	4/7/99	95,615	18	Lochsa R	Clearwater R M F	1997	Rel in Boulder Cr; 100% CWT 10-51-17/18;no ad clip
	Powell	CH	1	SP	4/7/99	4/7/99	47,950	19.1	Papoose Cr	Clearwater R M F	1997	100% CWT; no ad clip.
	Powell Total						**143,565**					
	Sweetwater Spr	CH	1	SP	7/21/98	8/13/98	480,585	46	Selway R	Clearwater R M F	1997	No fin clips; 6k PIT tag; Rel in Selway
	Sweetwater Spr Total						**480,585**					Moose & Bear Cr & Running & Whitecap cr.
	Willard	CO	1	UN	3/16/99	3/16/99	290,176	18.9	Lapwai Cr	Clearwater R M F	1997	1.5k PIT tag; 39.5k ad+CWT 61-26-04; 25k CWT only 61-26-05.
	Willard	CO	1	UN	3/18/99	3/18/99	278,182	22.4	Potlatch R	Clearwater R M F	1997	25k ad+CWT 61-26-06; 25k CWT only 61-26-03; 1.5k PIT tag.
	Willard Total						**568,358**					
NEZP Total							**3,520,204**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
ODFW	Big Canyon	ST	1	SU	4/7/99	4/7/99	119,648	4.6	Big Canyon H	Grande Ronde R	1998	Forced rel from lower pd; 100% ad clip; 25k adLV+CWT 09-25-63.
		ST	1	SU	4/8/99	4/21/99	119,608	4.6	Big Canyon H	Grande Ronde R	1998	Volit rel from upper pd; 100% ad clip; 25k adLV+CWT 09-25-62.
		ST	1	SU	5/19/99	5/19/99	103,829	5	Big Canyon H	Grande Ronde R	1998	Forced rel from lower pd; 100% ad clip; 25k adLV+CWT 09-26-04.
		ST	1	SU	5/20/99	6/3/99	104,489	5.1	Big Canyon H	Grande Ronde R	1998	Volit rel from upper pd; 100% ad clip; 25k adLV+CWT 09-26-03.
	Big Canyon Total						**447,574**					
	Cascade	CO	1	UN	3/26/99	4/2/99	1,010,608	17.9	Umatilla R	Umatilla R	1997	Rel at Rm 56; 25k ad+CWT 09-24-24-25;09-25-38
	Cascade Total						**1,010,608**					
	Lower Herman C	CO	1	UN	3/22/99	3/24/99	465,339	15.8	Umatilla R	Umatilla R	1997	Rel at RM 56; 27k CWT 09-24-23.
	Lower Herman C Total						**465,339**					
	Imnaha	CH	1	SP	3/16/99	4/16/99	184,725	18.5	Imnaha AcPd	Imnaha R	1997	100% adRV+CWT 07-12-48/09-26-12 14…16 & 19, 20k PITtag; Volitional rel start 5 p.m; Size of rel study.
	Imnaha Total						**184,725**					
	Irrigon	ST	1	SU	4/6/99	4/7/99	126,995	5	Grande Ronde R	Grande Ronde R	1998	100% ad clip; Rel in Gr Ronde Section R-2.
		ST	1	SU	5/7/99	5/7/99	800	4.5	Deer Cr	Grande Ronde R	1998	Experimental Lot; 100% ad + PIT tag; Sthd X Rainbow cross.
	Irrigon Total						**127,795**					
	Li Sheep	ST	1	SU	4/13/99	4/13/99	215,294	4.8	L Sheep AcPd	Imnaha R	1998	Forced rel; 100% ad clip; 50k adLV+CWT 09-25-60;09-26-34;.5k PIT
		ST	1	SU	5/18/99	5/18/99	119,378	5.4	L Sheep AcPd	Imnaha R	1998	Forced rel; 100% ad clip; 25k adLV+CWT 09-25-61; 250 PIT tag.
	Li Sheep Total						**334,672**					
	Lookingglass	CH	1	SP	3/15/99	4/1/99	312,145	21.6	Lookingglass H	Grande Ronde R	1997	100% adRV+CWT 07-01-48;07-07-49;09-26-20..22;45k PIT
		CH	1	SP	4/5/99	4/5/99	10,242	14.5	Imnaha R	Imnaha R	1997	100% ad+CWT 09-26-09; Some PIT Tags; Direct Stream Rel.
	Lookingglass Total						**322,387**					
	Oak Springs	ST	1	SU	4/7/99	4/9/99	62,218	6.1	Hood R	Hood R	1998	100% ad clip; Direct stream rel below Powerdale Dam.
		ST	1	WI	4/8/99	4/8/99	1,792	5.6	Hood R	Hood R	1998	100% adRV clip; rel below Powerdale Dam.
	Oak Springs Total						**64,010**					
	Round Butte	ST	1	SU	4/5/99	4/20/99	166,504	4	Bel. Pelton Dam	Deschutes R	1998	100% adRV clip.
		CH	1	SP	4/12/99	4/15/99	275,597	7.5	Bel. Pelton Dam	Deschutes R	1997	100% ad+CWT 09-26-51 thru 54; 2k PIT tag; Acclim & rel from Pelton Ladder.
		CH	1	SP	5/10/99	5/10/99	28,224	7.5	Bel. Pelton Dam	Deschutes R	1997	Forced from ladder on 5/10; 100% ad+CWT 09-25-51..54.
	Round Butte Total						**470,325**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	Wallowa	ST	1	SU	3/31/99	3/31/99	216,755	4.5	Wallowa AcPd	Grande Ronde R	1998	Forced rel from lower pd; 100% ad clip; 25k adLV+CWT 09-26-01; 250 PIT tag.
		ST	1	SU	4/1/99	4/19/99	218,711	4.3	Wallowa AcPd	Grande Ronde R	1998	Volit rel from upper pd; 100% ad clip; 25k adLV+CWT 09-26-02; 250 PIT tag.
		ST	1	SU	4/1/99	4/19/99	138,417	4.8	Wallowa AcPd	Grande Ronde R	1998	100% ad clip; fish transf from Irrigon H for volitional rel w/production fish on 4/1.
		ST	1	SU	5/12/99	5/12/99	116,072	5.3	Wallowa AcPd	Grande Ronde R	1998	Forced rel from lower pd; 100% ad clip; 25k adLV+CWT 09-26-06; 250 PIT tag.
		ST	1	SU	5/13/99	5/26/99	110,357	4.9	Wallowa AcPd	Grande Ronde R	1998	Volit rel from upper pd; 100% ad clip; 25k adLV+CWT 09-26-05; 250 PIT tag.
	Wallowa Total						**800,312**					
ODFW Total							**4,227,747**					
UMTR	Bonifer	ST	1	SU	3/18/99	4/13/99	44,226	5.5	Bonifer AcPd	Umatilla R	1998	Acclim. 1 mo at Bonifer; 100% ad clip; 20k adLV+CWT 09-25-25.
		ST	1	SU	5/4/99	5/4/99	35,564	5.9	Bonifer AcPd	Umatilla R	1998	Acclim 30 d at Bonifer; 100% ad clip; 20k adLV+CWT 09-25-27; .3k PIT tag.
	Bonifer Total						**79,790**					
	Imeques	CH	1	SP	12/20/98	12/21/98	114,370	18.1	Imeques AcPd	Umatilla R	1997	Freezing conditions caused emergency rel of fish; 40% ad+CWT 09-24-14-16
		CH	1	SP	3/8/99	3/8/99	253,831	13.7	Imeques AcPd	Umatilla R	1997	Acclim 2 mo; 100k ad+CWT 09-23-47;09-24-11-12-13
		CH	1	SP	3/8/99	3/8/99	177,655	16.1	Imeques AcPd	Umatilla R	1997	Transfer from L White Salmon H; acclim 1 mo; 20k ad+CWT 07-60-37; Portion PIT tag.
		CH	1	SP	4/14/99	4/14/99	228,121	12.9	Imeques AcPd	Umatilla R	1997	100k transfer from Carson/125k from L White Salmon H; acclim 1 mo; 40k ad+CWT 07-57-46; 07-60-38.
		CH	0	FA	6/3/99	6/3/99	1,842,666	55.9	Imeques AcPd	Umatilla R	1998	1-2 wk acclim; 100% ad clip; 1.3 million ad+BWT; 540k ad+CWT 09-27-01...05, 09-26-63;some PIT tags
	Imeques Total						**2,616,643**					
	Minthorn	ST	1	SU	4/6/99	4/14/99	41,843	4.9	Minthorn AcPd	Umatilla R	1998	Acclim 1 mo at Minthorn Pd; 100% ad clip; 20k adLV+CWT 09-25-26.
	Minthorn Total						**41,843**					
	Thornhollow	CH	1	FA	3/11/99	3/11/99	233,861	9.4	Thornhollow AcPd	Umatilla R	1997	Acclim 1 mo; 215k BWT; 25k ad+CWT 09-26-51.
		CH	1	FA	4/15/99	4/15/99	215,707	9.1	Thornhollow AcPd	Umatilla R	1997	Acclim 1 mo; 190k BWT; 25k ad+CWT 09-26-52; some PIT tags.
	Thornhollow Total						**449,568**					
UMTR Total							**3,187,844**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
USFW	Carson	CH	1	SP	4/20/99	4/20/99	1,415,744	12.6	Carson H	Wind R	1997	13k PIT tag; 100k ad+CWT.
	Carson Total						**1,415,744**					
	Dworshak	CH	1	SP	4/19/99	4/23/99	1,044,511	21	Dworshak H	Clearwater R M F	1997	910k ad clip only;140k ad+CWT;48k PIT tagged;35.8 k rel on 3/25/99.
		ST	1	SU	4/19/99	4/22/99	232,614	6.6	Clear Cr	Clearwater R M F	1998	100% ad clip.
		ST	1	SU	4/19/99	4/23/99	625,803	6.7	S Fk Clearwater R	Clearwater R M F	1998	100% ad clip; Rel at Red House Hole.
	Dworshak	ST	1	SU	4/26/99	4/30/99	1,248,133	6.6	Dworshak H	Clearwater R M F	1998	100% ad clip; 40k adLV+CWT+FB 100k adLV+CWT; some PIT tag.
	Dworshak Total						**3,151,061**					
	Entiat	CH	1	SP	4/7/99	4/7/99	354,238	11.3	Entiat H	Entiat R	1997	118k ad+CWT.
	Entiat Total						**354,238**					
	Hagerman	ST	1	SU	4/14/99	5/10/99	419,036	4.3	Little Salmon R	Salmon R	1998	100% ad clip; 40k ad+CWT; Rel at Stinky Springs.
		ST	1	SU	4/21/99	4/26/99	226,435	5	Sawtooth H	Salmon R	1998	100% ad clip; 120k ad+CWT 10-46-43-34 43..46; 10-53-1, 2,9&10;Lt/Early egg take study;.6k PIT
	Hagerman Total						**645,471**					
	Kooskia	CH	1	SP	4/6/99	4/9/99	570,290	17	Kooskia H	Clearwater R M F	1997	530k ad clip only; remainder ad+CWT.
		CH	1	SP	4/6/99	4/6/99	113,875	17.8	Clear Cr	Clearwater R M F	1997	50k ISS group; 100% LV clip; .5k PIT tag; 64k ad clip only; rel at County Rd Bridge.
	Kooskia Total						**684,165**					
	Leavenworth	CH	1	SP	4/19/99	4/19/99	1,636,402	17.2	Leavenworth H	Wenatchee R	1997	7.5k PIT tagged; 190k ad+CWT.
	Leavenworth Total						**1,636,402**					
	L White Salmon	CH	1	SP	4/20/99	4/20/99	1,074,173	14.3	Little White Salmon	Little White Salmon	1997	50k ad+CWT.
	L White Salmon	CH	0	FA	6/24/99	6/24/99	2,149,397	55.9	Little White Salmon	Little White Salmon	1998	200k ad+CWT
	L White Salmon Total						**3,223,570**					
	Spring Creek	CH	1	SP	12/25/98	12/26/98	194,200	25	White Salmon R	White Salmon R	1997	Early rel due to flood cond. at Big White Holding Pds; unmarked rel.
		CH	0	SP	3/2/99	3/12/99	214,900	600	White Salmon R	White Salmon R	1998	non marked fish;Early rel due to flood cond.at Big White Rearing Pds.
		CH	0	FA	3/18/99	3/18/99	4,065,232	117	Spring Creek H	Columbia R	1998	150k ad+CWT
		CH	0	FA	4/22/99	4/22/99	3,527,184	74.6	Spring Creek H	Columbia R	1998	150k ad+CWT
		CH	0	FA	5/13/99	5/13/99	2,999,659	60.1	Spring Creek H	Columbia R	1998	150k ad+CWT.
	Spring Creek Total						**11,001,175**					
	Willard	CO	1	UN	4/19/99	4/19/99	2,095,530	15.7	Little White Salmon	Little White Salmon	1997	100k ad+CWT
	Willard Total						**2,095,530**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	Winthrop	CH	1	SP	4/15/99	4/15/99	545,062	13.2	Winthrop H	Methow R	1997	7.5 k PIT tagged; 100% ad+CWT.
		ST	1	SU	4/15/99	6/10/99	112,908	5	Winthrop H	Methow R	1998	100% ad clip; volitional rel.
	Winthrop Total						**657,970**					
	Warm Springs	CH	1	SP	10/1/98	10/5/98	35,718	20	Warm Springs H	Deschutes R	1997	100% ad+CWT 05-43-55..57; 05-44-55,57;05-30-9;735 fish RV clip; Early rel due to gasoline spill u/s hatchery.
	Warm Springs	CH	1	SP	3/4/99	3/4/99	775,852	19	Warm Springs H	Deschutes R	1997	100% ad+CWT 05-43-55..57; 05-44-55..59; 05-30-9
	Warm Springs Total						**811,570**					
USFW Total							**25,676,896**					
WDFW	Chewuch	CH	1	SP	4/19/99	4/20/99	132,759	16.3	Chewuch R	Methow R	1997	100% ad+CWT 63-06-14.
	Chewuch Total						**132,759**					
	Chiwawa	CH	1	SP	4/19/99	4/26/99	266,148	11.7	Chiwawa H	Wenatchee R	1997	100% ad+CWT 63-7-40.
		ST	1	SU	4/26/99	5/18/99	172,078	6.9	Chiwawa H	Wenatchee R	1998	100% ad & Elast. tag [Red,green,orange]wild or cross
	Chiwawa Total						**438,226**					
	East Bank	SO	1	UN	11/9/98	11/9/98	197,195	21.3	Lake Wenatchee	Wenatchee R	1997	100% ad clip; no CWT; Rel from net pens.
		CH	1	SU	4/27/99	4/28/99	438,223	10.6	Dryden AcPd	Wenatchee R	1997	100% ad+CWT 63-6-12;46.5k dir stream rel on 4/28 w/CWT 63-04-40.
	East Bank Total						**635,418**					
	Klickitat	CH	1	SP	3/1/99	3/2/99	538,000	7.5	Klickitat H	Klickitat R	1997	86k ad+CWT 63-03-52; 63-04-36.
		CO	1	UN	5/3/99	5/5/99	1,100,000	16.3	Klickitat H	Klickitat R	1997	100% ad clip; 30k ad+CWT 63-12-17; 30k CWT only 63-12-18.
		CH	0	SP	5/11/99	5/11/99	40,600	81	Klickitat R	Klickitat R	1998	Rel in upper Klick. R basin for YIN; 100% ad+CWT 63-8-11.
		CH	0	FA	6/2/99	6/28/99	4,289,100	60.4	Klickitat H	Klickitat R	1998	3.5 mil. PR stock; 380k Mixed SR stock; 3.2 mil. BWT; 800k ad+CWT 63-10-2745;05-45-21; 09-27-50;2.4 mil. Rel 6/2-7
	Klickitat Total						**5,967,700**					
	Lyons Ferry	ST	1	SU	3/25/99	4/30/99	268,803	4.3	Cottonwood AcPd	Grande Ronde R	1998	100% ad clip; 90k adLV+CWT 63-04-60+FB[RA IT-3]
		ST	1	SU	3/25/99	4/30/99	124,651	4.9	Dayton AcPd	Walla Walla R	1998	100% ad clip; no other marks.
		CH	1	FA	4/1/99	4/13/99	432,166	8.3	Lyons Ferry H	Snake R	1997	100% ad+CWT 63-08-60+Elastomer tag [left red]. 4+FB [LA IV& 2 ad CV'5w/o LV clip[RA IV-1&3]; Excess plant of 8k rel on 4/23.
		ST	1	SU	4/15/99	4/23/99	87,992	3.7	Lyons Ferry H	Snake R	1998	100%ad clip; 80k adLV+CWT 63-10-2
		ST	1	SU	4/16/99	4/23/99	179,089	4.4	Tucannon R	Tucannon R	1998	100% ad clip; 40k adLV+CWT 63-10-01+Fb [RA IT-1].
		ST	1	SU	4/19/99	4/23/99	176,000	4.7	Walla Walla R	Walla Walla R	1998	100% ad clip only.
		CH	0	FA	6/15/99	6/15/99	204,194	47.8	Lyons Ferry H	Snake R	1998	100% ad+CWT 63-10-26; 1.5 k PITtag.
	Lyons Ferry Total						**1,472,895**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	Methow	CH	1	SU	4/15/98	4/25/99	384,909	11.4	Carlton AcPd	Methow R	1997	100% ad+CWT 63-9-36; Volitional Rel.
		CH	1	SP	4/15/99	4/30/99	332,484	17.3	Methow H	Methow R	1997	100% ad+CWT 63-06-13; Volitional release.
		CH	1	SP	4/15/99	4/18/99	26,714	15.7	Twisp R	Methow R	1997	100% ad+CWT 63-04-34.
	Methow Total						**744,107**					
	Priest Rapids	CH	0	FA	6/14/99	6/23/99	6,504,800	47.5	Priest Rapids H	Mid-Columbia R	1998	5 rel groups spaced 2 days apart; 200k ad+CWT 63-10-30; 3k PIT tag.
	Priest Rapids Total						6,504,800					
	Ringold Springs	CH	1	SP	2/27/99	3/1/99	400,000	11	Ringold Springs H	Mid-Columbia R	1997	Approx. 30% of the 1.28 million rel from hatchery - Emergency rel; 12k ad+CWT 63-5-9.
		ST		SU	3/17/99	3/26/99	181,000	5.7	Ringold Springs H	Mid-Columbia R	1998	100% adRV clip.
		CH	1	SP	4/1/99	4/4/99	875,000	9.3	Ringold Springs H	Mid-Columbia R	1997	45k ad+CWT 63-5-9.
		CH	0	FA	6/16/99	6/22/99	3,484,000	41.2	Ringold Springs H	Mid-Columbia R	1998	4.5K PIT tag; 400k ad+CWT63-10-10 46 & 47.
	Ringold Springs Total						**4,940,000**					
	Skamania	ST	1	WI	4/20/99	4/20/99	25,680	6.1	White Salmon R	White Salmon R	1998	Acclim in net pens at N. western Lake by coop sthd group; 17k Kalama stock 8k Lewis R stock; 19-00% ad
		ST	1	WI	4/23/99	4/27/99	9,633	6.2	Rock Cr	Columbia R	1998	100% ad clip.
		ST	1	SU	4/28/99	4/30/99	30,586	5.5	White Salmon R	White Salmon R	1998	100% ad clip.
		ST	1	SU	4/28/99	5/5/99	123,709	5.5	Klickitat R	Klickitat R	1998	100% ad clip; rel at RM 10, 18, 20, 22 & 27.
		ST	1	SU	4/29/99	4/29/99	14,840	5.5	Little White Salmon	Little White Salmon	1998	100% ad clip; Direct stream rel into Drano L.
	Skamania Total						**204,448**					
	Tucannon	CH	1	SP	3/11/99	4/20/99	24,186	15.6	Curl Lake	Tucannon R	1997	100% ad+CWT 63-61-32.
	Tucannon Total						**24,186**					
	Turtle Rock	ST	1	SU	4/20/99	5/15/99	145,000	6	Wenatchee R	Wenatchee R	1998	100% ad clip; 52.5k rel in April by Chelan PUD as part of survival study.
		CH	1	SU	4/21/99	4/21/99	202,989	6.1	Turtle Rock H	Mid-Columbia R	1997	100% ad+CWT 63-6-6.
		ST	1	SU	4/24/99	4/24/99	45,080	4.6	Entiat R	Entiat R	1998	100% ad clip.
		ST	1	SU	4/24/99	4/24/99	1,000	4.6	Turtle Rock H	Mid-Columbia R	1998	100% ad clip; Non migrators forced from pond.
		CH	0	SU	6/18/99	6/18/99	301,777	47.8	Turtle Rock H	Mid-Columbia R	1998	100% ad+CWT 63-9-37; Normal Rearing Program.
		CH	0	SU	6/23/99	6/23/99	307,571	23.4	Turtle Rock H	Mid-Columbia R	1998	100% ad+CWT; Accelerated Rearing Program.
	Turtle Rock Total						**1,003,417**					
	Washougal	CO	1	UN	4/1/99	4/16/99	2,514,927	18.1	Klickitat R	Klickitat R	1997	100% ad clip;60k ad+CWT 63-08-24;27; rel at various sites on Klick R.
	Washougal Total						**2,514,927**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	Wells	CH	1	SU	4/12/99	4/26/99	589,591	11	Similkameen AcPd	Okanogan R	1997	100% ad+CWT 63-6-10.
		CH	1	SU	4/19/99	6/9/99	381,687	6	Wells H	Mid-Columbia R	1997	100% ad+CWT 63-06-11; % PIT tag for Surv Study by Douglas PUD.
		ST	1	SU	4/20/99	5/12/99	40,226	7	Methow R	Methow R	1998	Part of Douglas PUD study; 100% ad clip & PIT tag; 30k rel at Pateros WA; 10k rel at mouth of Okanogam R
		ST		SU	4/21/99	6/7/99	96,225	5	Chewuch R	Methow R	1998	Parentage Hx W Cross; No ad clip with BWT cheek tag.
		ST		SU	4/21/99	6/8/99	127,513	5.1	Twisp R	Methow R	1998	Parentage HxW Cross; No ad clip with BWT cheek tag.
		ST	1	SU	4/27/99	5/12/99	34,099	10	Wells H	Mid-Columbia R	1998	Smaller fish rel from hat.; part of Douglas PUD study; 100% ad clip
		ST		SU	4/27/99	5/11/99	78,891	6.7	Okanogan R	Okanogan R	1998	100% ad clip; 10.6k rel in Omak Cr; 5k rel in Salmon Cr; 63k rel near town of Okanogan.
		ST		SU	5/5/99	5/7/99	71,820	6.3	Similkameen AcPd	Okanogan R	1998	100% ad clip.
		ST		SU	5/7/99	5/14/99	139,650	6.7	Methow R	Methow R	1998	100% ad clip; rel at RM 55, 57 & 61 (upper Methow)
		ST		SU	5/12/99	6/9/99	180,600	7	Effy Bridge	Methow R	1998	100% ad clip.
		CH	0	SU	6/18/99	6/21/99	370,617	24.8	Wells H	Mid-Columbia R	1998	100% ad+CWT 63-10-18.
	Wells Total						**2,110,919**					
WDFW Total							**26,693,802**					
WSTR	Blackberry Pond	CH	1	SP	4/8/99	4/20/99	45,647	7.1	Blackberry AcPd	Hood R	1997	100% adLV+CWT 09-25-55,56;Fish transf from Cell 4 & 5 at Pelton Ldr; Group 1 rel on 4/8; Group 2 rel on 4/21; Volit rel from pd.
		ST	1	SU	4/15/99	4/15/99	15,616	5.5	Blackberry AcPd	Hood R	1998	100% LM clip; Acclimated group.
		ST	1	SU	5/10/99	5/10/99	3,897	6.6	Columbia R Above I	Columbia R	1997	100% LM clip; non migrators from pd; rel near mouth of Hood R.
		CH	1	SP	5/11/99	5/11/99	6,175	8.3	Columbia R Above I	Columbia R	1997	Non migrators from pd; rel near mouth of Hood R; 100% adLV+CWT 09-25-55, 56
	Blackberry Pond Total						**71,335**					
	E Fk Sand Trap	ST	1	WI	4/15/99	5/5/99	23,002	5.7	E Fk Irrig Dist Sand	Hood R	1998	100% ad+RV; Acclim; 2 rel - 1 rel on 4/15; 2nd rel on 5/5; fish transf from Oak Springs.
		ST	1	WI	5/25/99	5/25/99	1,991	8	Columbia R Above I	Columbia R	1998	Non migrators from AcPd; rel near mouth of Hood R; 100% adRV clip.
	E Fk Sand Trap Total						**24,993**					
	Jones Cr Pond	CH	1	SP	4/8/99	4/20/99	26,041	7.1	W Fk Hood R	Hood R	1997	Acclim at Jones Cr Site; Transf from Pelton Ldr Cells 4 & 5; Volit rel start on 4/8 & 4/20; 100% adLV+CWT 09-25-55, 56
		CH	1	SP	5/6/99	5/7/99	13,147	8.3	Columbia R Above I	Columbia R	1997	Non-migrators from Pd; Rel near mouth of Hood R; 100% adLV+CWT 09-25-55, 56
	Jones Cr Pond Total						**39,188**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	Parkdale Pond	CH	1	SP	4/12/99	4/12/99	30,195	6.4	Parkdale AcPd	Hood R	1997	Fish transf from Pelton Ldr for acclim; 100% adRM+CWT 09-25-57.
		ST	1	WI	4/14/99	4/14/99	9,857	5.6	Parkdale AcPd	Hood R	1998	100% adRV clip.
		CH	1	SP	5/5/99	5/5/99	214	5.9	Columbia R Above I	Columbia R	1997	Non migrators from AcPd; 100% adRM+CWT 09-25-57; rel near mouth of Hood R.
		ST	1	WI	5/5/99	5/5/99	9,816	6	Parkdale AcPd	Hood R	1998	100% adRV clip.
		ST	1	WI	5/25/99	5/25/99	305	9.2	Columbia R Above I	Columbia R	1998	100% adRV clip; non migrators from AcPd; rel near mouth of Hood R.
	Parkdale Pond Total						**50,387**					
WSTR Total							**185,903**					
YATR	Clark Flat	CH	1	SP	3/18/99	6/1/99	231,220	15	Clark Flat AcPd	Yakama R	1997	100% marked; 25k PIT Tag; initial rel from new AcPd.
	Clark Flat Total						**231,220**					
	Cle Elum Slough	CO	1	UN	5/10/99	5/25/99	210,000	15	Cle Elem Slough	Yakama R	1997	Transf from Cascade H; 1/2 rel 5/10, 1/2 rel 5/25; 10k PIT tag; 54k ad+CWT 09-24-26; 09-25-39.
	Cle Elum Slough Total						**210,000**					
	Easton Pond	CH	1	SP	3/18/99	6/1/99	156,718	15	Easton Pd	Yakama R	1997	100% marked; 15k PIT Tag;Intl yr of operating facility.
		CO	1	UN	5/10/99	5/10/99	48,000	15	Easton Pd	Yakama R	1997	No Marks or clips.
	Easton Pond Total						**204,718**					
	Jack Creek Pond	CO	1	UN	5/10/99	5/25/99	240,000	15	Jack Creek AcPd	Yakama R	1997	120k rel on 5/10; 120k rel on 5/25; fish transf from Cascade & Speelya H & rel in upper Yakama R; 10k PIT tag; 25k ad+CWT 09-24-27; Remainder no clip.
	Jack Creek Pond Total						**240,000**					
	Leavenworth	CO	1	UN	4/28/99	5/30/99	419,000	15	Leavenworth H	Wenatchee R	1997	7k PIT tag; no other clips or marks.
		CO	1	UN	4/28/99	5/10/99	67,500	15	Nason Cr	Wenatchee R	1997	No marks or clips.
	Leavenworth Total						**486,500**					
	Lost Creek	CO	1	UN	5/7/99	5/25/99	320,000	15	Naches R	Yakama R	1997	160K rel on 5/7; 160k rel on 5/25; no clips; 10k PIT tag.
	Lost Creek Total						**320,000**					

Agency	Hatchery	Spec	Age	Race	RelDate	RelEnd	Num Rel	Size	Release Site	River Name	Brood	Comments
	Prosser	CH	0	FA	4/26/99	4/26/99	113,000	60	Prosser AcPd	Yakama R	1998	100% LV clip; used Yakama R broodstock; initial release.
		CH	0	FA	5/24/99	6/4/99	1,690,000	70	Prosser AcPd	Yakama R	1998	200k ad+CWT 05-01-02-10-02; Transf from L White Salmon H.
		CH	0	FA	5/25/99	6/4/99	79,000	60	Prosser AcPd	Yakama R	1998	100% RV clip; Initial rel of juvenile fchin from Yakama R broodstock.
	Prosser Total						**1,882,000**					
	Stiles Pond	CO	1	UN	5/7/99	5/25/99	182,000	15	Naches R	Yakama R	1997	91k rel on 5/7; 91k rel on 5/25; transf from Speelya & Cascade H; 10k PIT tag; no clips.
	Stiles Pond Total						182,000					
YATR Total							**3,756,438**					
	Grand Total						**81,520,721**					